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INHERITANCE, FERTILITY, AND THE DOMINANCE OF SEX AND COLOR IN HYBRIDS OF WILD SPECIES OF PIGEONS

POSTHUMOUS WORKS OF CHARLES OTIS WHITMAN

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EDITORIAL STATEMENT.

Seven manuscripts bearing on the subject of this volume, nearly 2,000 pages of breeding record, and about 200 illustrations with accompanying legends comprised the material from which the present volume is assembled.

The first of these manuscripts was written in 1897. It treats of inheritance as limited by sex, and is placed in Chapter XII. Two lectures in 1898 supplied the materials for Chapter XVI and for a fragment of Chapter XI. The third manuscript dates from about 1904, and was slightly revised later. It is the most general and comprehensive treatment of the series and is here made to serve as an introductory chapter. Some tabulations or lists which accompanied this paper have, however, been separated from it and expanded to include studies made after 1904. These expansions treat partly of some crosses made earlier than 1904 but not adequately summarized at that time, and partly of crosses made later by the author and summarized wholly by the editor. These completed summaries now appear as Chapter II. The fourth manuscript, "On the Divisibility of Characters," was written in 1906 and is the basis of Chapter XVII. The fifth, dated 1907 and entitled "Heredity," touches the broader aspects of development and becomes the first section of the concluding statement of Chapter XIV. To this statement have been added three or four pages on "Mendelian Heredity" from a lecture in 1908 and some other materials from the papers next to be mentioned, which have also found their natural place in the same chapter.

A seventh and very incomplete manuscript (R 16, WW 1), consisting largely of short summaries and conclusions drawn chiefly from later studies, was written in 1909 and 1910. The conclusions found here, though disconnectedly set down in about 30 small pages, represent Professor Whitman's most mature and final judgment in regard to his work with the dominance of sex and color, with its control, and with the dependence of this result upon relative "fertility" and "strength" of the germ-cells.

The major task of the editor has been the summarizing of the data on which these conclusions from the work of the author's later years were based and their tabulation and presentation. In most cases this has meant the tabulation of data concerning breeding, quotation from the specific record where possible, and from the notes of the seventh manuscript till this was fully presented; and, finally, undertaking such analysis and discussion as seems absolutely necessary to render it available to students. But such analysis and discussion by the editor have perhaps not been unduly pressed; indeed, the editor believes that, although he has worked much, the reader has yet something to do to avail himself of all that lies in the volume. The results of this effort to present fully these materials may be found chiefly in Chapters II to XIV inclusive. The elaborateness of the detailed tabulations in those chapters—unusual as this method of presentation is—will be found quite necessary because of the nature of the problems treated. For this reason, too, it was deemed advantageous greatly to amplify from the numerous later records the relatively few summaries made by the author and to add many unsummarized earlier records as well.

The close of Professor Whitman's life, late in 1910, left many problems connected with the present volume quite unfinished. The reader is asked to bear in mind that the author did not consider this work concluded—even at the end of the 16 years of his study of pigeon hybrids. It was quite important to the purposes of these studies, (1) that the data for longevity and sex of the 600 pigeons that survived him should be learned and added to his records; (2) that certain untested "mutants" be given a breeding-test. Both of these additional tasks were also accepted by the editor and performed by him—not well, but with the measure of success that has been possible in connection with much other work and under circumstances not at all times wholly favorable.

Collectively the seven manuscripts noted above comprise rather less than 100 typewritten pages. It thus becomes evident that the reader will meet with the words and work of the editor at very many points and that some method must be found for distinguishing in these pages author from editor. In the main, this has been accomplished by the use of certain postscript letters,¹ but in part also by the use of quotation marks, these latter being most used in the designation of short statements, words, or phrases, transcribed from breeding-records and notes. The postscript letters are placed after longer treatments, complete manuscripts, etc. These take the form of (A 1), (C 7/16), (Sh 14), etc., and in textual materials are placed at the close of the writings of the author. In the tables these letters are uniformly placed at the lower right-hand corner of the table. The tables constructed from breeding data obtained by the editor bear his initials in the same position in the table. It is believed that the reader will be able to know or to learn the source of all the statements and materials of the volume. He will bear in mind that all of Dr. Whitman's data were obtained prior to December 1910 and that the editor is responsible for all thereafter.

The postscripts just described have a further and important use. It has been necessary for the editor to make hundreds of summaries of breeding records and to write whole chapters. He hopes—and most sincerely believes—that he has made a faithful transcript of the original records; but so much hangs upon this matter that he has not felt that he cares to act as the sole or ultimate translator or interpreter of these materials. The postscripts given in these volumes are therefore fully given and refer to the "shelving or folder classification" given by Dr. Whitman to the original manuscripts. It is planned to file all of these original materials with the Carnegie Institution of Washington, either at its administration building in Washington or at the Station for Experimental Evolution at Cold Spring Harbor. There they will be available to all interested parties; all of the original records, or any specific ones of these, may there be freely and easily consulted.

In the earlier papers, and also in the one used as an introductory chapter, Whitman was unable to bring forward the remarkable results which were to follow (then only beginning to be observed) bearing on the control of sex in pigeons; but he there (1904) partially outlined a relation between fertility and sex and furnished reasons for the following conclusions: (1) that wild forms of unquestioned purity possess a great advantage over domesticated varieties in a study of some of the

¹This is a continuation of the plan or method adopted for Volume I of these works.

laws of heredity and evolution; (2) that in the study of variation it is necessary to go beyond the biometrician's curve to a knowledge of "the history of the individual phenomenon"; (3) that dominance is a thing of many degrees, and is far from representing a natural law; (4) that in wider crosses, at least, blended inheritance seems to be the more general phenomenon; (5) that very many gradations of "fertility" exist; (6) that apparently some of the most interesting facts of development can be learned only through a utilization of such known gradations of fertility; (7) that males only (or almost exclusively) result from numerous crosses in which fertility ("germ compatibility") is much reduced by a choice of birds widely separated in the pigeon group.

The more important conclusions of the seventh paper—the extended series of short statements, not really in manuscript form—were as follows: (1) that fertility ("germ compatibility" and "germ strength") in its varying degrees is closely associated with the production of sex and color; (2) that fertility varies much in *individuals* of the same species, at different *ages* and at different stages of the *season*; (3) that in general the "stronger germs" arise toward the first of the season and tend to produce males; the "weaker germs" produced in late summer, especially by birds "overworked at reproduction," tend to produce females (and more white color); still later there is a tendency to a production of eggs capable of little or of no development; (4) that there is a predominance of males from the first egg and of females from the second egg of the pigeon's clutch;² (5) that the male goes further in development and arises from a "stronger germ" than does the female; (6) that strength in the parents tends, among pigeons, to produce male offspring; (7) that inbreeding in pigeons leads to the production of weaker germs; (8) that immaturity and old age in pigeons are also associated with the production of weaker germs; (9) that white color, albinism, and color "mutations" may arise, by quantitative variation, from the weak germs incident to inbreeding, old age, and lateness of season; and that such quantitative variations ("mutations") are proved to be of genetic value; and, furthermore, that with pigeons, by simple known means, one should be able progressively to shift the "strength" of their germs so as to secure either a greater or a smaller number of these "mutations."³ In other words, Whitman's later studies constitute a discovery and a partial analysis of certain means of so modifying the germ-plasm as to carry it from one developmental and hereditary capacity to another; and in the light of these results to affirm continuity, quantitativeness, and fluidity regarding the bases of the hereditary characters in question—fertility, sex, and color. This, too, at a time when very many of his fellow biologists have, in large measure, been closely committed to the view that discontinuity, qualitativeness, and fixity are the essential bases of hereditary phenomena.

These latter interpretations are, of course, currently thought to be especially well founded in connection with the heredity of sex. It is of the highest importance, therefore, that sex is one of the characters which has apparently been thus approximately brought under control.

²This is true for many "pure (wild) species"; see a further statement at the close of Chapter XIII.

³A more complete consideration of "mutations" is given in Volume I. They are treated in the present volume only in so far as they are one—a rather infrequent one—of the several phenomena exhibited by "weak germs."

Results which thus strongly impel to so radical a change in opinion concerning the bases of hereditary phenomena will undoubtedly be subjected to the stoutest opposition; the more so, inasmuch as admittedly these studies were not as complete as their author had wished to make them. But it is believed that a full examination of the data of the volume will go very far toward demonstrating that Whitman found material and methods for shifting, changing, or reversing the developmental and hereditary capacities of the germ-cells. The materials of Volume I, which treat evolution as an orthogenetic process, afford also something more than full and complete harmony with this result.

To the general statement of the previous volume concerning a lack of full treatment in these works of the pertinent literature a word should be added here. It is in the present volume that this lack of adequate treatment of contemporary literature will be found most evident. There are three facts to be noted in explanation: (1) the materials of this volume were in a less advanced state of preparation than were those of the companion volumes; (2) the rather plentiful abstracts and notes of current literature which came into the editor's hands were in such form as to raise a question as to their utility, particularly since the main purpose here has necessarily been to present the author's data and conclusions; (3) much of the important work upon the general subject treated here has appeared during the rather long period required for the preparation of these works for publication.

It would be unfair to the author to omit the further record that to him is certainly due the entire credit of having first demonstrated a "shifting of dominance" series. His colleagues, in Chicago at least, were, during several years, quite well aware of his results.

In the preface to Volume I we make specific acknowledgments to those whose assistance, sacrifices, interest, and generosity have made possible the preparation and publication of this work.

OSCAR RIDDLE.

STATION FOR EXPERIMENTAL EVOLUTION,
Cold Spring Harbor, New York, June 1915.

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VOLUME II

CHAPTER I.

INTRODUCTORY.¹

All domestic breeds of pigeons, of which there are probably not less than 200 distinct kinds, are fertile when crossed and the offspring of crosses are also fertile. The same holds true, so far as known, between the domestic races and the wild rock-pigeons, and this fact is generally held to be a strong indication of common ancestry.

In the case of the wild species of pigeons, of which there are nearly 500, crosses are very often infertile, and fertile hybrids are so rare that Darwin could not find "a single well-ascertained instance of hybrids between two true species of pigeons being fertile *inter se*, or even when crossed with one of their pure parents" (*Animals and Plants*, I, p. 237). The records since Darwin's time have not furnished the "instance" he vainly sought for.

Even if fertile hybrids were sometimes obtainable, the possibility of establishing an "intermediate" race between two wild species would presumably be very doubtful, since such a result as Darwin points out is extremely difficult even in the case of domestic breeds where the hybrids are perfectly fertile. Darwin says: "Certainly, a breed intermediate between two very distinct breeds could not be got without extreme care and long-continued selection; nor can I find a case on record of a permanent race having been thus formed." (*Origin of Species*, 5th ed., p. 33.)

The results of experiments with wild species since Darwin's time have been very meager; with comparatively few exceptions, domestic animals and cultivated plants have been preferred to wild species. The very important advantages of natural species for such work have either been entirely overlooked or greatly underestimated.

The difficulty with domestic forms is that they have a complex ancestry which we can never hope to unravel. These forms are themselves the products of a most tangled series of hybridizations,² and hence they give, for the most part, unpredictable results—"reversions," "regressions," "mutations," "sports," *et id genus omne*. With such material each individual, as Galton³ puts it, "should be viewed as the fulfillment of only one out of an indefinite number of mutually exclusive possibilities." The unfulfilled possibilities lurk about in so-called "latent" characters that may sleep for generations and then appear as variations which obey no law except "the law of large numbers," which virtually says: "There is no explanation for the individual phenomenon; be satisfied to know that it is one of many phenomena which always follow that wonderful curve of chance which defined itself by Newton's binomial theorem, and which is so useful in its application to life insurance, pension laws, etc."

Without demurring to the many interesting applications of "the law of large numbers," it must not be forgotten that the individual phenomenon fulfills itself

¹This paper was written (1904-5) under the caption "Hybrids of Wild Species of Pigeons."—EDITOR.

²Mendel, pp. 25, 26, on variability of cultivated plants.

³Natural Inheritance, p. 18.

by law, of which Quetelet's curve takes no note. For the discovery of this law, the *history* of the phenomenon must first be ascertained. It is from just this history that the large-number curve diverts attention.

But some will urge that this history is too complex and inaccessible to study. Assuredly it is hopelessly involved in forms whose interminglings have gone on for ages unrecorded. In many wild species, however, the record has run on with such uniformity that the ancestry becomes practically a simple line stretching back through thousands of years without a break. In such cases ancestry is all summed up in parentage, and we can safely say that, knowing the species, we know both parents and ancestors. In crossing two species we may predict the results with considerable detail, for the hybrids do not carry a load of unknown latent characters and the characters they develop can be referred directly to those of the two parent species.

In fact, in pure forms we see neither "sports"⁴ nor "reversions," but straight and full delivery of what heredity has packed in the germs. The delivery is as precise as the blending of two parental germ-cells can make it. With such forms, in which there has been not only continuity but purity of germ-plasm, we escape endless perplexities, and Galton's problem of finding a precise numerical statement for "the average share contributed to the personal features of the offspring by each ancestor severally" becomes greatly simplified.

In the case of a hybrid between the common ring-dove (*Streptopelia risoria*) and the very distinct Asiatic red ring-dove (*Streptopelia humilis*) we do not have to figure out the "shares" of parents, grandparents, etc. We see the characters of both species so evenly blended in the hybrids and in the offspring of the hybrids when paired *inter se* that we can say that each parent has had an equal share, just as we should describe the color of the mulatto as a "half-tint" and that of the quadroon child of the mulatto and the white as a "quarter tint." The color, as a whole and in each feather and part of a feather, the form and proportions, the size, and even the instincts and the voice, the number of notes, manner, time, and rhythm of delivery, follow closely the same simple formula. It is in such cases that we see, as I believe, inheritance in its purest form, with "chance" phenomena reduced to a minimum and the endless circuities of mixed filial relations excluded.

The "conviction that inheritance is mainly particulate and much influenced by chance" (Galton, *Natural Inheritance*, p. 19), and the conclusions that therefore "the science of heredity is concerned with fraternities and large populations rather than with individuals," shows to what extremities we are pushed as the result of attending too exclusively to forms of highly mixed ancestry. Nothing in the experience of breeders is more certain than that long-continued, promiscuous intermixing of stocks leads to instability and chaotic confusion in the transmission of characters. Characters are thus, as it were, churned up until their typical distribution in the developing organism is more or less deranged. Of course, chance results are then conspicuous and laws are masked under distortions. Mixture is random, characters are placed in unnatural relations, broken up, and scattered as if sprinkled from a pepper-box. The appearance is very "particulate" and the "large-number" curve is perhaps a refuge to be grateful for. Such conditions

⁴ A very few cases of "mutations" were later found. They are described in this volume and in Volume I.—EDITOR.

are graphically pictured in the colors of the thoroughly mongrelized domestic pigeon, and even in some of the so-called "pure" breeds, described as "mottled," "mealy," "grizzled," "splashed," "spangled," "well-broken," etc.

It would seem to be obvious that *purity* of stock is the first essential for eliminating "chance" phenomena. Purity is not to be found in domesticated forms, nor yet in wild species that show intermingled forms. The terms "pure," "true," "constant," as used by breeders, mean nothing more than a degree of uniformity capable of being artificially maintained by careful selection and mating. The best almond tumbler, for example, according to Fulton⁵ (p. 155) "will only remain what it should be for at most two seasons."

The purity requisite for scientific purposes is the self-sustaining purity found only in unmixed natural species, such as are represented in large numbers and convenient forms in the wild pigeons. Over 450 distinct species are recognized in Salvadori's "Catalogue of Birds in the British Museum." In this large group, undoubtedly arising from a single root and having much apparent homogeneity, the species are remarkably distinct, even in nearly allied forms. Sometimes two species are so nearly alike in size, form, and color that they appear, even to the trained eye, to be one and the same. When the two are brought together in life, fairly sharp distinctions are quickly detected in the voice, proportions, color, and behavior, and crosses give hybrids that demonstrate specific distinctness. The wild ring-dove of Japan and China (*Streptopelia torquatus*)⁶ and the eage ring-dove (*Streptopelia risoria*) are two such species. As *St. risoria* is not known in a wild state and is probably of Africane origin, and as *St. torquatus* enjoys geographic isolation from it and its nearest relatives, it is safe to conclude that the two species are pure with respect to each other, and their purity as regards other sources is not open to doubt. The hybrids from these two species are intermediates, but incline somewhat towards *torquatus*, as is particularly manifest in voice and color.

Although *St. torquatus* appears to be somewhat prepotent in crosses with *St. risoria*, its superiority does not reach exclusive dominance in a single namable character. Mendelian dominance does not exist, and the law that fails in the first generation of course can not hold in the second. *Dominance, so far as my observations go, is a thing of many degrees, and is far from representing a natural law.* Even allowing that it is a rigid rule in one or a few species, that would not raise it to the rank of a law, if the test of a law is universal application.

In crossing the wild passenger-pigeon (*Ectopistes migratorius*) with the eage ring-dove (*St. risoria*), the hybrids have so far been invariably remarkably close intermediates, and without exception sterile males. If this rule should hold in experiments continued for a hundred years, it would still have no claim to being a general law. At most it would only be a proved rule for a particular cross; in another cross the blending may be only partial, both sexes may appear, and one or both be fertile. The rule would be broken in every point, and obviously two contradictory rules do not make one valid law. The regularity which we may discover in individual cases, no matter with what detail, accuracy, and constancy fulfilled, rises to the dignity of law only when referred to causes or processes of a general nature.

⁵ Fulton's Book of Pigeons, London, 1895.

⁶ *Streptopelia douraca* was later used as the proper name of the oriental ring-dove. See Chapter XVI.—EDITOR.

We are undoubtedly justified in assuming that some principle underlies such definite results of hybridization as Mendel discovered in peas. But that principle, if it be dominance, as supposed by Mendel,⁷ can only be a principle of as many degrees and exceptions as dominance itself, from which it is clear that dominance can be no more than an accident, and an accident that as yet we can discover only by the resulting segregation phenomena.

Segregation is thus bound up with dominance, following it in all its degrees and exceptions. A "law" must level all contradictions between dominance and blended inheritance. At present the latter seems to be the more general phenomenon.

Dominance, strange to say, seems to disappear in blend between widely distinct species, and to come more into view as the species are more closely related.⁸ De Vries goes so far as to make Mendel's laws a test for species, forms subject to them being thus shown to be of one species (1902, p. 141). This seems strange if dominance means antagonism of characters, since the more highly differentiated characters might be expected to stand farther apart and to be more and more difficult to blend. What, then, can be the nature of dominance? Then, too, the less dominance we see in the first generation of hybrids, the more segregation we see in the second.

In such questions as we are dealing with—dominance, segregation, ancestral and parental influence, etc.—it would be an advantage to know as intimately as possible just what the specific characters are, how they are related phylogenetically, whether they represent ancient or recent acquisitions. This history of characters will presumably assist in understanding the results of crossing.⁹

It is desirable also that the characters for study be of a definable kind—localized differentiations rather than whole characters, such as "self" or "whole" colors. The latter are of interest, but do not tell us so much as the regional character.¹⁰

The infertility of crosses is not to be confounded with sterility; it stands rather for various degrees of specific incompatibility between the germ-cells of the cross-mated birds. We do not know what this incompatibility means, but it is certain that it is in no way accounted for by external causes, such as difficulties in copulation or in the conjugation of the sperm and ovum. In many cases the development of the egg is carried far enough—to the formation of a blood-circle—to show that the sperm has entered the egg and fertilized it. The development may halt at this point or earlier, or be carried on to any later stage, even to hatching. The young bird may die within a few hours, or live on, apparently doing well, for several days, a week, or more, and then drop off as if life were a time-fuse calculated to end at a definite moment.

⁷ See Mendel, p. 27, "If furthermore," etc.

⁸ The blond ring-dove and the white ring-dove may be taken as two most nearly related forms, and the Japanese turtle-dove and the domestic dove as two wide-apart species, belonging to two different families according to systematists.

⁹ The data on this subject will be found in Volume I.—EDITOR.

¹⁰ See Weldon, *Biometrika*, 1, 2, Jan. 1902, p. 228. Weldon here gives (p. 245) the history of the Telephone pea, and says it exhibits "a gradual series of transitional colors from a deep green to an orange yellow." "Peas of all the transitional forms figured (6) were numerous." They show also "every conceivable condition" between smooth and wrinkled forms (p. 246). According to Mendel, a hybrid pea, like Telephone, should after at least 25 generations contain only round peas, if "round" is dominant (p. 246). "The law of segregation, like the law of dominance, appears therefore to hold only for races of particular ancestry" (p. 251). De Vries and von Tschermak have offered formulae for other plants, but they have just as little prospect of proving valid generally as Mendel's formula (p. 252).

The term of development to which we have just made reference often lies within such definite limits that, once ascertained, we may know about what to expect in future trials with the same birds. In the pigeons I find that the length of the course to be run, although varying widely, is, on the average, cut shorter and shorter as the crosses range from close allies to more distantly related species.

The causes of infertility in crosses—or, more correctly, the causes of fertility in lower and lower degrees as the divergence between the crossed species increases—have yet to be investigated. What connection, if any, do such phenomena have with the formation of so-called “pure” germs in hybrids? If “purity” is a thing of degrees, as it most certainly is, do the degrees rise or fall with fertility? Furthermore, if degrees are so numerous as to appear to flow together, can a few cases of approximate “purity” be claimed as a law? Do higher degrees differ in kind from lower, and so justify the assumptions of “discontinuity,” “mutation,” etc.? If two wide-apart degrees are found with no intergrades, how easy to conclude that they are both “sports” without genetic connection.

In dealing with such questions, the first requisite is material suited to give definite answers. In this respect the pigeon group is an ideal one, for it is composed of so large a number of closely graded species that it must afford some positive evidence of “flowing degrees,” if such exist, and at the same time give us the directions of rise and fall in a considerable number of well-defined differential characters. For the experimental side of the study we require not only species that will cross with continued fertility, but also species that will cross with varying degrees of fertility. Both are essential and both are represented in this group in exceptional abundance.

As there are between 400 and 500 distinct species of wild pigeons, and as nearly every species may be presumed to be fertile with at least one other species, the number and variety of fertile crosses possible must, at the lowest estimate, be quite large. But the number is probably many times larger, for a single species may be fertile with all or most of its congeners and, in lower degrees, with members of other genera and even of other families.

The common ring-dove, for example, is fertile not only with some dozen other species of its genus (*Streptopelia*, collared doves), but also in lower degrees with the typical turtle-doves, as two successful tests—one with the European turtle-dove (*Turtur turtur*) and another with the Surate turtle-dove (*Spilopelia suratensis*) of Burma and the Malay Peninsula—sufficiently attest.¹¹ In still lower degrees it is fertile with the mourning-dove (*Zenaidura carolinensis*), with the white-winged pigeon (*Melopelia leucomela*), and with many races of domestic pigeons.

How much farther the fertility of this species may extend remains to be tested. Some other ring-doves, as the wild species of China and Japan (*Streptopelia douraca*) and the red ring-dove (*St. humilis*) of the same countries, give evidence of equally strong fertility in crosses. The Oriental or Japanese turtle-dove (*Turtur orientalis*) promises an even wider range of fertility, as I have obtained one fertile hybrid between it and *Columba livia domestica*. This is, I believe, the most remarkable case of fertility hitherto recorded. It would certainly be difficult to match it in any other group of the higher animals. The offspring of this hybrid exhibit to

best advantage some of the most interesting phenomena of heredity, and I am convinced that this is the kind of material now most needed in attacking the all-embracing subject of the evolution of species.

The wild species of pigeons, in themselves and in connection with the domestic pigeons, offer a boundless field for the experimental study of variation and heredity. The many and closely grading species, with many sharply defined characters; the wide range of fertility, adapted to many modes and lines of experiment; the perfection and ease of control; the fulness and extent of the background of knowledge available in many cases; the possibility of knowing in advance the main facts of ancestry and the position of the species in the genealogical tree of the group, are all important advantages for such study. (A 1/7)

CHAPTER II.

CROSSES AND FERTILITY OF WILD SPECIES OF PIGEONS.

The species employed with some success in crossing are the following:

	<i>Feral species.</i>	
1. Oriental turtle-dove	Turtur orientalis Lath.	
2. European turtle-dove	turtur Linn.	
3. Chinese turtle-dove	Spilopelia chinensis Scop.	
4. Tiger turtle-dove	tigrina Temm.	
5. Surate turtle-dove	suratensis Gm.	
6. Senegal turtle-dove	Stigmatopelia senegalensis Linn.	
7. Blond ring-dove	Streptopelia risoria ¹ Linn.	
8. White ring-dove	alba Knip and Temm.	
9. Japanese ring-dove	douraca Hodgs.	
10. Red ring-dove	humilis Temm.	
11. Cape ring-dove	capicola Sundev.	
12. Damar ring-dove	damarensis Finch and Hartl.	
13. Passenger-pigeon	Ectopistes migratorius Linn.	
14. Mourning-dove	Zenaidura carolinensis ² Linn.	
15. Zenaida-dove	Zenaida vinaceo-rufa Ridgw.	
16. White-winged pigeon	Melopelia leucoptera Linn.	
17. Wood-pigeon	Columba palumbus Linn.	
18. Tibetan pigeon	leuconota Vig.	
19. Guinea-pigeon	guinea Linn.	
20. Wild rock-pigeon	livia Bonn.	
21. Stock-dove	cenas Linn.	

Domestic races crossed with feral.

22. Fantail (black)	Columba laticauda.
23. Fantail (white)	laticauda.
24. Homer	tabellaria.
25. Tumbler	gyrans.
26. Archangel	illyrica.
27. Mondain	admixta.
28. Chequered rock	affinis domestica.
29. Two-barred rock	livia domestica.
30. Owl-rock hybrid	turbata \times livia.

Besides these primary crosses, most of the hybrids have been bred, or, where not fertile, the fertility has been repeatedly tested. In other cases fertile hybrids have been crossed with hybrids of other species, and as many as five species thus combined in a final hybrid. (A 1/7)

Other wild species bred in captivity.

31. Spotted pigeon	Columba maculosa Temm.
32.	rufina Temm.
33. Band-tail	fasciata Say.
34.	gymnophthalmia Temm.
35. White-crowned pigeon	leucocephala Linn.
36. Eversmann's dove	eversmanni Bp.
37. Inca-dove	Scardafella inca Less.
38.	Leptoptila reichenbachii Pelz.
39.	brachyptera G. R. Gr.
40.	chloropterina (?) Gigl. and Salv.
41. Crested pigeon	Ocyphaps lophotes Temm.
42. Zenaida-dove	Zenaida amabilis Bp.
43. Bronze-wing	Phaps chalcoptera Lath.
44. White-faced pigeon	Leucosarcia pictata Lath.
45. Red-shouldered dove	Geopelia humeralis Temm.
46. Peaceful ground-dove	tranquilla Gould.
47. Barred ground-dove	striata Linn.
48. Diamond-dove	cuneata Lath.
49. Quail-dove	Geotrygon sp.
50. Florida ground-dove	Champæpelia passerina Linn.
51. Ground-dove	talpacoti Temm.
52. Bronze-wing	Phaps elegans Temm. (SS 2).

¹ Bonaparte, Consp. Av., 11, 63, 1854. See Chapter XV for full discussion.—EDITOR.

² Two specific names are in use for the mourning-dove. The A. O. U. Check-list adopts *macroura*, given by Edwards (Birds, I, p. 125, 1750) and accepted by Linnaeus (S. N., ed. x, 1758). This pigeon, however, has been almost universally known, both in Europe and America, as *carolinensis*, a name bestowed by Catesby (Car., I, p. 24, 1754). The use of this name has been sanctioned by an overwhelming majority of authors and in all the standard works on pigeons. (Further treatment of the definition of several of the species of *Streptopelia* here listed is given in Chapter XV and in Vol. I.—EDITOR.

Some breeding behavior which is quite as instructive as that secured from crosses has been obtained from the simple breeding (*i.e.*, without crossing), and from the inbreeding, of individuals of the same species or race. This is true for both wild species and domestic breeds or races of pigeons. Among the latter are the pouters, homers, and barbs. The zenaïdas, ground-doves, Oriental or Japanese turtles, and guinea-pigeons are the wild species of most importance in this respect.

In this type of mating some of the effects of age and season on germs and offspring are displayed free from the complications added by hybridization, while, on the other hand, the results thus obtained prove most helpful in the understanding of similar phenomena obtained in the crosses.—(EDITOR.)

The following primary crosses (not including crosses of varieties of domestic pigeons) have been made:

List of crosses.

Cross.	Description.	Relationship.	Sex of hybrids.	Remarks on hybrids.
1	<i>Male.</i> C. admista × T. orientalis	Fam.	8♂ ¹	Infertile.
2	C. tabellaria × T. orientalis	Fam.	5♂, 1♀	No test for fertility.
3	C. affinis domes. × T. orientalis	Fam.	2♂, (1♀?) ²	1♂ fertile w. dom.
4	Orientalis-ris. × C. tabellaria	Fam.	1♂	1 no gonad; 1 indif. behav.
5	C. gyrans × risoria-alba *	Fam.	11♂ ³	Not long lived.
6-7	Ect. migratorius × alba-ris × ris-alba	Fam.	8♂ ³	All interm.; infertile.
	St. alba	Fam.	2♂	Shade paler; infertile.
	St. risoria	Sub-fam.	16♂	2 no gonad; infertile.
	risoria × alba *	Sub-fam.	.....	1 hatched; short lived, many eggs.
8-11	Zen. carolinensis × alba-ris × ris-alba *	Sub-fam.	2♂	6 others bat.; 3 wk. to 30 mo.
	Za. vinaceo-rufa *	Gen.	2♂, 1♀	Fertile.
12-13	Vinac.-carolin. × St. alba *	Sub-fam.	1♂ or ♂?	+2 adults w. no gonad.
	St. risoria *	Sub-fam.	3♂+1?♂	Gonads minute in adult
14	Complex carol-vinac. hyb. × ris-alba × ris-alba *	Sub-fam.	.....	1 adult w. no gonad.
	T. turtur *	Sp.	7♂, 4♀	♂ fertile.
15-17	T. orientalis × St. alba *	Gen.	37♂, 37♀	Partial fertility.
	St. risoria *	Gen.	4♂, 6♀	Partial fertility.
18	Orientalis-alba × St. risoria . . . . .	.....	1♀	Infertile.
19	Orient.-ris-tur-alba × alba-orient . . . . .	.....	2 hermaphrodites, predom. ♀ . . . . .	.....
20	Orientalis-risoria × ris-tur-alba . . . . .	.....	2♂, 1♀	♂ fertile.
21	Orientalis-risoria × alba . . . . .	.....	7♂, 4♀	♂ fertile.
22	T. turtur × T. orientalis *	Sp. —	7♂, 14♀	Fertile.
23	Turtur-orientalis × hum. × hum-ris	Gen.	2♂, 3 . . . , 1? hermaphrodite	♂ fertile.
24	Tur-orient-hum-ris × St. alba . . . . .	.....	1♂	?; not tested.
25	Tur-orient × hum-ris × St. risoria . . . . .	.....	7♂, 1♀	1 adult w. no gonad.
26	Alba-ris × ris-alba × T. turtur	Gen.	3♂, 3♀	Fertile.
27	Alba-ris × ris-alba × Sp. suratensis	Gen.	1♂	Fertile with alba.
28	Risoria-humilis × alba	Gen.	8♂, 6♀	1 full-term embryo.
	T. orientalis *	Gen.	.....	Partial fertility.
	Sp. chinensis	Gen.	.....	No young raised.
29-34	St. risoria × St. alba	Sp. —	2♂, 6♀	Fertile.
	St. douraca	Sp.	8♂, 5♀	(+1?♀) fertile.
	St. humilis	Sp.	4♂, 3♀	(? = 7♂, 4♀) fertile.
	alba-orientalis . . . . .	.....	1 acts as ♂; 3 w. no plain gonad . . . . .	.....
35	Alba-ris × ris-alba × C. tabellaria (?)	Fam.	1♂, 1?♀	Lived few da. to 4 yr.
	St. risoria	Sp. —	7♂, 7♀	Fertile.
36-38	St. alba × St. humilis	Sp.	18♂, 18♀	Fertile.
	T. orientalis *	Gen.	60♂, 43♀	Partial fertility.
39	Humilis-risoria × St. alba	Sp.	4♂, 3♀	Not tested.
40	Alba-risoria × C. tabellaria * (?)	Fam.	-♂, 2?♀	(4?) short-lived.
41	St. douraca × St. risoria	Sp.	2♂, 3♀	Fertile.
42	Risoria-alba × St. douraca	Sp.	2♂, 4♀	Fertile.
43	Ris-alba-surat. × St. humilis . . . . .	.....	1♂	? not tested.
44	Turtur-orientalis * × alba-risoria	Gen.	1♀	3 alive.
45	C. domestica × St. risoria	Fam.	.....	2 yg. short-lived.
46	Sp. chinensis × Sp. suratensis	Sp.	1♂, 1♀	Short-lived.
47	Sp. suratensis * × St. risoria *	Gen. —	1♂, 1♀	(+1?♂, +2?♀) fertile.

¹ Professor Whitman listed 8 here in a summary (A 1/7); the editor has the original data for only 6.

² Ovary very rudimentary.

³ The records (NS 4) show 8 males; "one acted as a female, but was killed by Dr. Guyer and found to be a male."

These records also show 2 males from the *migr.* × *alba* cross.—EDITOR.

⁴ These (two) additional crosses were obtained (1911 and 1915) by the editor with the birds of the Whitman collection.

* The crosses marked with an asterisk (*) have been added from the records, by the editor, to an early summary (A 1/7) made by Professor Whitman.

List of crosses (continued).

	Description.	Relationship.	Sex of hybrids.	Remarks on hybrids.
	<i>Male.</i>	<i>Female.</i>		
48-49	Stig. senegalensis \times { St. alba *	Gen. —	10♂, 6♀	Fertile.
	St. risoria *	Gen. —	7♂, 3♀	(+1♂ or hermaph.).
50-51	Senagalensis-alba \times { Sp. tigrina *	Gen. —	2♂, 1♀	(?) lived 2 to 5 mo.
	St. risoria *		10♂, 1♀	1 sex abnormal.
52	Senegalensis-ris \times St. alba *		1♀	Lived 3 years.
53	Orient-tur-ris-alba \times St. capicola *			Uncertain.
54	St. humilis \times St. risoria	Sp.	11♂, 12♀	Fertile.
55	St. damarensis \times risoria-alba *	Sp.	2♂	Not tested.
56	Za. vinaceo-rufa \times Zen. carolinensis *	Gen. —	9♂, 6♀	Fertile.
57	Mel. leucoptera \times alba-ris \times ris-alba	Sub-fam.	1♂	2♂: infertile.
58	C. turbata \times C. livia (or dom.)	Sp.	10♂, 8♀	Fertile.
59	C. leuconota ^b \times C. livia	Sp. +		1 hat; died young.
60	C. ornata \times C. livia domest.	Sp. +	3♂, 2♀	Fert. w. domestica.
61	C. adminta \times C. palumbus	Sp. +		2 died at 4 to 7 da.
62	Laticauda-risoria \times C. gyrans *	Sp. +		3 not long-lived.
	(C. tabellaris)			
63-64	C. guinea (No. 1) \times { C. turbata-C. livia	Sp. +	3♂	8 hat; 7 lived 1 to 19 da., 1 lived 15+ mo.
	C. affinis domestica	Sp. +		8 hat; lived 5 to 10 da.
65-65b	C. guinea (No. 2) \times { C. tabellaris	Sp. +	1♂, 1♀	9 hat; 1 9 ⁴ inf.; 1♂ fertile.
	C. turbata-C. livia	Sp. +	2♂, 4♀	Lived 10 to 20 mo.
66	Turbata-tabellaris \times turtur-orientalis	Sp. +	10♂, 7♀	4 hat; lived 7 to 10 da.
67	C. tabellaris \times St. risoria	Fam.	2♂	Lived 1 da. to 3 yrs.
68	C. laticauda (white) \times St. risoria	Fam.	1♂	Infertile.
69	C. gyrans \times St. risoria	Fam.	7♂	Weakly fertile.
70	C. illyrica \times St. risoria	Fam.	1♂	Infertile.
71	C. adminta \times St. risoria	Fam.	6♂	4 lived few da.; inf.
72	C. laticauda (black) \times St. risoria	Fam.	21♂	Infertile?
				(A 1/7)

^a Cross made (1911) by the editor.^b It does not now seem certain that this bird was a female; it acted as one, but laid no eggs. I find no record of an autopsy.—EDITOR.^c The data for this cross as found in a summary in A 1/7; the original data are not available to the editor.

The crosses marked with an asterisk () have been added from the records, by the editor, to an early summary (A 1/7) made by Professor Whitman.

STATEMENT BY THE EDITOR.

It will be seen that a number of hybrids are here used as members of primary crosses. The method used in the preceding lists and throughout this volume of naming or designating hybrids, therefore, requires at this point a word of explanation.³ This method will probably become clear from an explanation of a single example. In cross No. 23 of the above list the composition of the two birds entering the cross is expressed as follows: *Turtur-orientalis* \times *hum.* \times *hum-ris*. That part of the formula which is written in front of the largest \times (or $\times \times$) gives the composition of the male used in the cross; in this case *T. turtur* and *T. orientalis*. The order of these two specific names indicates at the same time that this hybrid sire has a *turtur* father and an *orientalis* mother, since the designation of the male parent always precedes that of the female parent in every formula and in every part of a formula. Similarly the portion of the formula written after the largest \times (or $\times \times$) gives the composition of the female, in this case *humilis* \times *humilis*.

³ This is only in part the method used by Professor Whitman in making his records. He used two methods; in the later years he employed a numerator-denominator formula in which the numerator gave the composition of the father and the denominator that of the mother. He used an initial, or single letter, to designate a species and grouped these symbols somewhat as in the method described above. His description of a bird of the composition of the one given above had the following form: $\frac{T-O}{11-h-s}$. It seemed to the editor that this sort of nomenclature, though very convenient for making the records, is not well suited to the purposes of publication.

risoria. The arrangement of this part of the formula indicates that the female (used as dam in this cross) had a pure *humilis* father and a mother which was hybrid between *humilis* and *risoria*. The hyphen (-) is used instead of a small symbol (x) to indicate the more remote unions or matings. The hybrid that results from the cross of the two birds of cross No. 23 just cited will itself be designated by the formula exactly as written above, i.e., *turtur-orientalis* \times *humilis* \times *humilis-risoria*.

In all of the tabulated breeding records of the succeeding chapters the composition formula for the male bird which is used as sire is written as the numerator and that of the female as the denominator of a fraction. It is believed that as the reader proceeds he will find the method followed here is an easy and natural one and that it gives completely and in reasonably compact form the pedigree of the bird.

Included in the preceding list of primary crosses are the data for the number of males and of females produced by each cross. A general statement concerning the fertility of the hybrids is also given for most of the crosses. In addition, it has been thought well to give the degree of relationship of the two forms crossed, i.e., whether they are of specific, generic, subfamily, or family distinction. In some of these cases the degree of distinction has been more fully indicated by plus (+) and minus (-) signs placed after the words "species," "genera," etc. The designation "gen. +" then is intended to state that the two forms of a particular cross belong to different genera and that these two genera are perhaps more unlike than are those genera designated "gen. -."

Table references to 72 primary crosses.

Cross.	Table.	Cross.	Table.	Cross.	Table.	Cross.	Table.
1	1, 5	19	62	38	23, 24, 29, 30, 42, 43, 44	56	91
2	2, 3, 4	20	54		141	57	166
3	4	21	54	39	116	58	82, 83, 83a
4	118	22	7, 7a	40	59	166	
5	114	23		60	134	60	85
6	165	24		41	136	61	87
7	165	25		60	136	62	113
8	100, 101, 102	26	119	43	153	63	63, 64
9	103	27	151	44	125	64	
10	104	28	141	45	110	64	
11	93	29		46	166	65	
12	106	30	(¹)	47	150	66	15
13	105	31	128	48	157	67	115
14	107	32	134, 136	49	160	68	111
15	8, 9, 10	33	139	50	164	69	112
16	25, 31, 33, 34, 35, 37, 38, 39, 40, 41	34	51	51	159	70	108
17	48	35	50	52	161	71	110
18	52	36	117	53	Page 75,	72	(²)
		37	127	54	140		
			138	55	166		

¹ Not tabulated.

² Data not available.

The list of crosses—containing the summaries and statements just mentioned—gives, in a very condensed form, clear and adequate evidence for two important conclusions which are treated at length in succeeding chapters. These conclusions are (1) that the hybrids which arise from crosses of forms more and more distantly related show less and less fertility, and (2) that the sex of the hybrids which arise from crosses of forms more and more distantly related becomes more and more predominantly male.

It is also well to note in the list the frequency of hermaphroditism and the entire absence of gonads in hybrids from "wide" crosses. The author has little noted this matter; but the autopsies of some hundreds of his hybrids, made by the editor, and the complete summaries of all of the records demonstrate, in the opinion of the editor, that hermaphrodites are far more frequent in the offspring from wide crosses and from hybrid parents than from intra-specific and pure-bred matings.

In order to facilitate the consultation of the complete breeding record, in connection with an examination of the data for sex and fertility, as summarized in this chapter, a list of table references (p. 12) has been prepared. The numbers in the left-hand columns of that list correspond to the number of the cross (in the pre-

Individual matings testing absolutely infertile.

Description.	Width of cross.	No. of eggs tested.	Reference to original MSS.
Orientalis (19) × gyrans (1903).....	Fam.	16	F 22
Orientalis (1) × gyrans (1).....	Fam.	12	C 7/6
Orientalis × domestica (black).....	Fam.	15?	F 22
Domestica-orientalis (F2) × domestica.....		6	F 26
Domestica-orientalis (F2) × livia.....		4	F 26
Domestica-orientalis (A1) × gyrans (T1).....		2	F 24
Adinista-orientalis × gyrans.....		12	G 18
Domestica-orientalis × domestica.....		2 4	A 13
Orientalis × risoria-orientalis.....		5	F 14
Risoria-orientalis-orientalis.....		3	F 18
Orientalis-risoria (6) × alba-risoria × turtur (D7).....		2	F 18
Alba-orientalis (3) × alba-orientalis (5).....		14	F 9
Ocyphaps × risoria.....	Subfam.	16	C 7/46
Risoria × Ocyphaps.....	Subfam.	20	X 11
Risoria (M1) × Ocyphaps.....	Subfam.	10	X 9
Risoria (M1) × Ectopistes (1II-B) (do not know No. eggs).....	Subfam.	4	BB 5
Risoria (M1) × gyrans (T5).....	Fam.	?	X 11
(This ♂ (M1), however, only partially fert. w. an alba × ris. hyb.)		10	X 11
Risoria × gyrans (T5).....	Fam.	8	X 9
Risoria (G/F2) × gyrans (1).....	Fam.	2	C 7/6
Risoria (2) × carolinensis.....	Subfam.	6	DD 8
Risoria × chinensis.....	Gen.	10	DD 13
Risoria (A) × chinensis (T.c.).....	Gen.	6	X 4
Chinensis × risoria.....	Gen.	2	DD 13
Domestica × palumbus.....	Sp.	22	F 29, A 13
Tumbler (T6) × maculosa (?) trace of dev. in I).....	Sp.	3	G 21
Turbata × risoria (F)—(I, 1 to 2 da. emb.).....	Fam.	13	C 7/46
Ilyrica (Arl) × alba (W2).....	Fam.	6	C 7/28
Ilyrica (Arl) × risoria-alba.....	Fam.	4	C 7.28
Tabellaria (Hom. 2) × risoria (L1).....	Fam.	13	C 7.3
♂ Risoria-alba × G. humeralis.....	Subfam.	13	C 7.12
Risoria-alba (ZD 201) × gyrans.....	Fam.	25	G 19
Domestica-risoria × alba (W).....		25	C 7.39
Risoria-dourcæa × Geotrygon.....	Subfam.	2	XX8
Carolinensis × alba.....	Subfam.	30	C 7.7
Carolinensis-risoria (C1) × risoria (F of 1899).....		4	C 7.47
Carolinensis × alba-risoria (XW 2 C 2).....	Subfam.	4	C 7.47
Carolinensis × alba-ris × ris-alba (N2-O).....	Subfam.	3	C 7.47
Carol-ris × alb-ris × ris-alb × alb-ris × ris-alba.....		4	C 7.47
Migratorius-risoria × alba-ris × ris-alba.....		2	Sh 32.13
Domestica-risoria × archangel-tumbler.....		13	C 7.35
Alba-ris × ris-alba × carolinensis (2, E1).....	Subfam.	10	C 7.23
Alba-ris × ris-alba × domes-ris × gyrans (T4).....		7	C 7.47
Alba-risoria × risoria-alba × carolinensis.....	Subfam.	4	X 7
Alba-risoria × risoria-alba × carolinensis.....	Subfam.	7	C 7.21
Alba-ris × ris-alba × tigrina × × ris-alba.....		6	DD 17

ceding lists), and this latter number is followed by the number of the table or tables in which this record, or the chief part of it, may be found.

An additional list of all⁴ "individual matings which tested absolutely infertile" is given herewith. From this list it is evident that the primary cross of widely separated forms is itself less and less fertile in proportion to the degree of the separation of the forms. Nearly all of these completely infertile matings comprised forms of family or of subfamily distinction. Few matings of forms only specifically or generically different proved wholly infertile, although the total number of such matings made was many times the number of family and subfamily matings.

Those who are not acquainted with the classification of Columbæ will find the diagram given herewith (as arranged by the author, in part after Salvadori, 1893) of help in obtaining a general idea of this subject. Later reference to this schematic arrangement of the various groups of pigeons will enable the reader to learn or to verify the degree of separation of the members of the more distantly related crosses.

Classification of Columba.

Order Columbæ.	Suborders	{	1. Columbæ.
			2. Didi (extinct).

Order COLUMBÆ				
	Suborder	<i>Columba</i>	<i>Didi</i>	
Family	1 Treronidæ,	2 Columbidæ	3 Peristeridæ	
4 Gourideæ			5 Didunculidæ	
			↓	
	Fam. Peristeridæ			
Subfamily	1 Zenaidinæ,	2 Turturinæ,	3 Geopelineæ	4 Peristerinæ
	5 Phabinæ,	6 Geotrygoninæ	7 Caloenadinæ	

Number of genera and species in each family.		Genera and species of the family Peristeridæ.	
Genera.	Species.	Genera.	Species.
Columbæ:			
Treronidæ.....	19	Zenaidinæ.....	4
Columbidæ.....	9	Turturinæ.....	5
Peristeridæ.....	40	Geopelineæ.....	3
Gourideæ.....	1	Peristinæ.....	6
Didunculidæ.....	3	Phabinæ.....	12
Total.....	72	Geotrygoninæ.....	9
2 extinct		Caloenadinæ.....	2
No. of doubtful species, 27.		Total.....	40
			156

Groups of genera most used in crosses.

PERISTERIDÆ.	PERISTERIDÆ.	COLUMBIDÆ.	
Genera of Turturinæ	{ Turtur. Streptopelia. Spilopelia. Stigmatopelia.	Genera of Zenaidinæ.	Genera of Columbinæ...Columba. Genera of Ectopistinæ...Ectopistes.
		Genera of Zenaida. Melopelia.	

⁴ A few additional matings of this sort are fully presented later in the breeding records.

CHAPTER III.

FERTILITY AND THE SEXES.¹

"Fertility varies much in individuals of the same species, at different ages and at different stages of the season.

"The sexes in normal fertility are about even.

"The sexes in lowered fertility show a predominance of males.

"The sexes in much lowered fertility are males only.

"The sexes in the lowest fertility do not appear—no offspring.

"Lowered fertilization shows various degrees, in which development makes a feeble beginning, then halts after a few days. It may run up to within a few hours or days of hatching and then halt. The developmental processes may also show different degrees of energy fullness, weakness, irregularities, etc., *after* hatching.

"When fertility is presumably not up to normal, certain colors—such as white—may be exclusively female. White rings are of both sexes—but in hybrids between white rings and Japanese turtles the white offspring are all females."² (R 16)

Whitman's later studies—all of which were in evidence at the time the above was written (1910)—clearly show that fertility does not bear a single, simple relation to sex, but a sort of *double* relation. Indeed, the double relation which fertility, or at least which "fertility" and "developmental energy," bear to sex would at first sight seem to be contradictory.

Nowhere has Whitman written connectedly or fully on this seeming contradiction, nor has he written very extensively upon the multitude of facts and illustrations bearing upon the second relation which he discovered that fertility bears to sex. This rather meager exposition of these important results was in keeping with a studied policy not to allow himself to write, or definitely to fix opinions, until he had studied the facts from all possible angles of approach. In the records of his last six or seven years of work, however, one finds very frequent allusions—a word or a phrase—to this second relation which he found that fertility bears to sex, and which at this time he undoubtedly considered as of equal or of even greater importance than the earlier discovered one. Briefly stated, this second result is that, in many crosses of very distinct species or of genera, fertility (developmental power) is shown to be *highest in the spring and lowest in the autumn; and that male offspring predominate in the season of highest fertility, while females³ largely predominate in the season of lowest fertility.*

But, we ask, how can this fail to contradict the first result—compactly stated above in the second paragraph under this section—which lists "much lowered fertility" as producing "only males"? It is necessary to treat this whole matter immediately and at some length.

¹ The editor has written this chapter; the author's statements are here placed in quotation marks.

² "Herbst (Arch. f. Entw. Mech. vol. 24, No. 2, 1907) thinks that resemblance to father and mother is settled by the size of the copulating nuclei. If female nucleus is at highest level, the resemblance is towards the maternal side. It is sheer *superiority in energy.*"

³ Color and longevity in the offspring are also, to an appreciable extent, affected in the seasonal shift of fertility and sex; these characters, however, may to advantage be considered elsewhere.—EDITOR.

At the outset we would note that the second paragraph, referred to above, is not an amplification or explanation of the first paragraph; but each paragraph tells of a different and main fact that had been learned concerning fertility. The two succeeding paragraphs contain statements true alike for, and associated with, both of the two main facts on fertility.

The tabular statement of the second paragraph is of course merely a condensation of a lengthy consideration already given in the introductory chapter concerning the fertility of crosses in pigeons. We herewith reproduce, for the sake of clearness and convenience, paragraphs covering the essential points:

"The infertility of crosses is not to be confounded with sterility; it stands rather for various degrees of specific incompatibility between the germ-cells of the cross-mated birds. We do not know what this incompatibility⁴ means, but it is certain that it is in no way accounted for by external causes, such as difficulties in copulation, or in the conjugation of the sperm and ovum. In many cases the development of the egg is carried far enough—to the formation of a blood-circle—to show that the sperm has entered the egg and fertilized it. The development may halt at this point, or earlier, or be carried on to any later stage, even to hatching. The young bird may die within a few hours, or live on, apparently doing well, for several days, a week, or more, and then drop off as if life were a time-fuse calculated to end at a definite moment.

"The term of development often lies within such definite limits that, once ascertained, we may know about what to expect in future trials with the same birds. *The length of the course to be run, although varying widely, is, on the average, cut shorter and shorter as the crosses range from close allies to more distantly related species.*"

Again: "The causes of infertility in crosses, or more correctly, the causes of fertility in lower and lower degrees as the divergence between the crossed species increases, have yet to be investigated. . . . A single species may be fertile with all, or most of its congeners, and, in lower degrees, with members of other genera and even of other families."

From his earlier work, then, the author learned that if pigeons most widely separated phylogenetically were mated, the fertility ("germ compatibility") there was lowest and that no offspring could be had. If forms somewhat less widely separated were chosen for matings, some germs were fertilizable, and in development these would almost or quite invariably produce males. Forms still less removed phylogenetically when crossed produced males predominantly; and so on until closely related forms are reached which are fully fertile, and which throw the sexes in approximately equal numbers. If, then, we allow birds to produce their "strongest germs" (no reproductive overwork), but progressively cut down the fertility of these by choosing consorts more and more distantly related, we thereby increase the chances of producing male offspring,⁵ as long as any offspring may be obtained. This is the gist of the earlier findings on the relationship of fertility and sex.

⁴ One can perhaps profitably remind himself here of the situation involved in anaphylaxis, immunity, etc.—EDITOR.

J. Loeb (Arch. f. Entwick'mech., Bd. 27, 1908) finds in the extremely wide crosses which he has made with lower forms that the products of parts of the foreign sperm finally act as a poison and cause the eggs to develop abnormally. O. Hertwig (Arch. f. Mikr. Anat., Bd. 82, 1913) further finds that such foreign or poisonous substances contained in the sperm may be neutralized or destroyed by prolonged treatment with radium. Godlewski (Arch. f. Entwick'mech., Bd. XXXIII, 1911) has called attention to the analogy between these features of fertilization and certain aspects of immunity.—EDITOR.

⁵ This holds true also for matings (some genera) from which every egg, or almost every egg produced, is fertilized and hatched.—EDITOR.

The second main fact on fertility ("germ strength") was developed from observations on the gradations which this function presents in different individuals of the same species, and which it may undergo in one and the same individual. Age, season, and the rate at which eggs are produced were all found to affect the heights or levels of fertility in pigeons. And the two sexes were here also found to be associated with fertility ("germ strength")—maleness with greater fertility (strength), femaleness with weaker fertility. It is this aspect of fertility that is referred to in the first quoted paragraph.

From some of those crosses in which fertility was "lowered" and the resulting offspring were "predominantly male" it was noted that the "occasional" females more often appeared *at or near the end of the season*. Moreover, such results were more frequently obtained in such of the matings as had produced a greater number of eggs than usual, as a result of the prompt removal of these eggs as soon as laid to other birds for incubation. In other words, *reproductive overwork, in such a series, tends towards the production of female offspring*. Lateness of season and crowded reproduction seemed each to play a part in the production of females from gametes otherwise producing only or mostly male offspring. These earlier indications were confirmed by later work. The body of evidence bearing on these points must, of course, be presented later, but we note here the fact that often—in a mating of the above sort in which the dominance of sex is shifted during the season from maleness to femaleness, under "crowded reproduction"—some embryos are produced very late in the season not strong enough to break through the shell; and still later, embryos are produced of fewer and fewer or of no days of development. These weak germs, at this season, may proceed from a pair whose earlier eggs—of spring and early summer—produced hatchable, vigorous, and long-lived birds which were mostly or only males. The *loss of fertility* during the *season*⁶ involves, then, a progressive weakening of the germs themselves after starting from a given—reduced—level of fertility (germ compatibility) produced by selecting consorts of distant phylogenetic relationship. There are, then, two distinct kinds of things that have been called "lowered fertility"; and the two means of obtaining a low (or a high) fertility very differently affect the production of sex.

A few paragraphs—immediately following the first four given at the beginning of this chapter—bear upon this matter of "weakened germs." They were written beneath the caption: "Strength in Parents Tends to Produce Male Offspring."

"There is from pigeon crosses a preponderance of males from first eggs, and of females from second eggs. The first egg of the clutch may be supposed to have the advantage, as its needs are provided first, and the second egg, which is always the last of a clutch, has not quite equal chances, for it does not have first chance."⁷

"I think the first eggs of the season are certainly stronger than those coming late in the season. Elsewhere the early birds are the ones most highly prized by breeders. In poultry

⁶ This loss of fertility ("germ strength") is to be observed in the eggs of much "overworked" females, whether they are mated to one of their own or of a very different species.—EDITOR.

⁷ Whitman writes (W 9) that "The male and female have potentially the same characters. Usually the female lags behind, but sometimes the male lags," and cites Darwin's Descent of Man, Vol. II, pp. 191–199, and Beddoe's Animal Coloration. This subject is more fully treated in Volume I, Chaps. V–VII.

generally we expect to get the best results from the earlier birds hatched, and fewer failures occur in early settings than in later.⁸ (R 16).

With these several statements before us it is possible to approach more closely to an understanding of the author's whole view of fertility, and to see that the two lines of fact which he developed concerning it are consistent, though at a glance we seem to say, first, that "lowered fertility" tends to the production of males, and second that "lowered fertility" tends to produce females.

The facts are that so long as we operate upon the function of fertility *merely by a choice of consorts*—and this on a basis of close or distant phylogenetic relationship—then the more we reduce the fertility the higher the proportion of male offspring, and the series runs thus:

- (1) In normal fertility the sexes are about even.
- (2) In lowered fertility males predominate.
- (3) In much lowered fertility only males are produced.
- (4) From the lowest fertility no offspring develop.

If, however, we take a pair of birds from groups (2) or (3) of the above scheme (and this will usually mean doves from different genera or subfamilies) and further study and analyze the genetic possibilities of this pair, we find that over and above the fertility incident to such a mating *per se* this degree of fertility is influenced by season, age, health, and reproductive work. And, associated with "lateness of season" and "reproductive overwork" there occurs an obvious decrease in fertility (developmental power) caused, not as in the preceding series, through relative "incompatibility of germs," *but by a progressive weakening of germs*; and the initial "lowered fertility" *plus this weakening of germs, may produce females*. Each sex predominates when its characteristic fertility level exists.

No. (3) of the above series if thus amplified and written in terms of this second series of facts would stand as follows:

Much lowered fertility ⁹ + strong germs = nearly all males.

Much lowered fertility + medium strong germs = sexes about equal.

Much lowered fertility + weaker germs = females.

Much lowered fertility + weakest germs = no development.

⁸ "De Vries holds that *species* are separated by *absolute* gaps, that can not be closed up. They arise by jumps or as sports. Were this the case, we ought to see sudden gaps in 'fertility.' I find that fertility is a thing of degrees, i.e., it is at an optimum within the species, but it diminishes gradually—not by steps—as we pass from the crosses between species closely related to crosses of species wide apart. Examples of such a series are the following: White and blond ring; Japanese ring and blond ring; blond ring and Chinese ring; blond ring and European turtle; blond ring and Surate turtle; blond ring and homer. And similar to the last named, blond ring and *Ectopistes*; white or blond ring and mourning-dove; blond ring and white-wing; common pigeon and Japanese turtle." (These five last-named crosses are all of *family* or of *subfamily* rank.—EDITOR.)

"Again, fertilization within the species is of every degree, and results therefore in simple penetration of sperm which fails to make more than an early beginning of development or nothing at all, or it may give stages of change, etc., up to blood formation, and from this point it may go on and stop after forming an embryo, or at any point up to hatching; and when hatched, the fate is not yet settled; the bird may be deformed and still live; it may be too weak to develop further or go on and die at three, four, five, six, or more days. All along the line we see that development requires energy and stops or goes wrong for failure in this. Young birds often make failures. Doves reach the highest point at three to four years. . . . The energy of development and degree of fertility appear to be correlated."

⁹ Obtained by mating birds distantly related; "strength" is, in all probability, added by the act of crossing.—EDITOR.

Color, like sex, is to some extent involved in this flux of strength of germs. Dark and white, at any rate, are sometimes thus involved; dark color being the more closely associated with strong germs, whiteness more often associated with weak germs, though instances of sex-limited color inheritance were found which, apparently at least, do not at all conform to this rule.

A statement may be made at this point concerning the author's interpretation of this seasonal change of fertility, sex, and color. Neither of these did he ever refer to as a "shifting of dominance," partly because he had assured himself of the incompleteness or inadequacy of Mendelian and representative particle conceptions of heredity,¹⁰ and therefore preferred, in such instances, not to use that terminology; partly also because his data inclined him to believe that in this seasonal change from males to females there is a real reversal or change in the sex-potency of the individual germs, due to or in accord with the weakening effects which (as fertility) he had repeatedly observed and partially analyzed; that is to say, a given pair of germ-cells which, if matured and united under one set of conditions (strength) will produce a male, can be made under another set of conditions (weakness) to give rise to a female.

The author of course thoroughly appreciated the possibility that selective fertilization, differential maturation, and selective mortality of ova in the ovary might conceivably here be operative, and that one or all of these would be appealed to by others, who had not seen all that he had seen, to account for this "shifting of dominance" or apparent sex-reversal. Nor did he permit himself a definite or final decision of the question of sex-reversal.

The evidences within the "shifting-of-dominance" series itself, which to him most strongly suggested real sex-reversal as the correct interpretation of the series, were: (1) the demonstration that there is a *gradual* diminution in developmental power of the germs of these same series from spring to autumn—sometimes a nearly continuous line along which are strung males, males and females, females, female embryos, and embryos of fewer and fewer days of development, to a point of very little or no development; (2) the demonstration that stronger and longer-lived birds arise from the earlier, stronger germs than from the later and latest ones. This latter result he has himself noted only in cross-bred series. The attention of the reader will often be drawn to this matter in the case of the wider crosses; moreover, since all the records have been summarized and the longevity data put in place by the editor, it has become apparent that to an extent the same fact holds true in the overworked pure-bred series as well as in the cross-bred series.

The following quotation from Lumley¹¹ (p. 35) will show that among fancy or domestic pigeons some of the "weakening" effects of overwork at egg-laying have been recognized by breeders of these forms:

"Fancy pigeons generally show an inclination to mate together some time in the month of February; but much depends upon the temperature, as in very severe weather they will sometimes show no signs of doing so until March, whilst if it be mild some birds, if allowed, would go to nest in January. This, however, the owner should in all cases prevent, by keeping the sexes separate, for several reasons. In the first place, though it is possible the

¹⁰ See Chapter XIV.

¹¹ Fulton's Book of Pigeons. London, 1895. The quotation given was indicated by means of a page reference by the author; it was not copied into the author's manuscript.—EDITOR.

young ones may be reared, and if the weather keeps mild throughout they will in that case make wonderfully strong early birds, still the chances are many against it. But still more though the young be reared, the result is likely to be the ruin of the constitution of the hen; for if she is what is called a free breeder, or lays her eggs fast, before the season is over she becomes so weak as in many cases to become ruptured, and in other cases barren, when she is of course valueless. The cause of this is not only the excessive laying—indeed a young and rank hen will often lay, like a fowl, whether she be mated or not—but the cock-bird continually driving her to nest and teasing her while in her weak state, which causes her weakness of course to increase, until the ovary gives way, and she becomes what is called “down behind.” A most singular fact is that we have often noticed the mate of such a hen to become similarly affected, in which case he is commonly said to be “gizzard-fallen”; but having dissected many birds in such a condition, we can state positively that the gizzard has nothing to do with it, but that the part affected is a portion of the intestines. We never knew a cock breed in such a condition; and though we have occasionally known a hen do so, the progeny of such birds could not be expected to have any but a weakly constitution. In any case, it is much better to get even only three or four pairs of eggs in a season, hatched at a time when they are likely to become strong and healthy birds and preserve the constitution of the parents also for next season. We have known some persons, by what is called “pumping” a hen, or breeding from her as long as possible, obtain eight or nine pairs of eggs from her in one season; but we have seldom known more than half reared, and often some of these would have crooked breast-bones, which is a great fault as well as a sign of weakness. And as to the hen herself, she is, as already stated, if not entirely ruined, seriously debilitated for life, so that none of her after progeny will be as vigorous as they ought to be.”

The data of this volume will show that the various species of wild pigeons and many of their hybrids can be overworked, or “pumped,” very much more extensively than is indicated above for the domestic pigeon breeds, and without such evident permanent *somatic* injury to the parents. A more complete analysis of the relation of season and the order of the egg of the clutch (in *wild* species) to this weakening, and the relation of all of these points to fertility and to sex is, however, treated for the first time in these pages.¹²

It may be emphasized that Professor Whitman was by no means inclined to dogmatize as to the interpretation of this sex series. The editor had ample opportunity to know the author's mind on this subject better than on most others, since during the winter of 1908–9 it was decided that the present editor should join in an attempt to learn more of the germs which might beforehand be known to be of male-producing or of female-producing value. The chemical investigations then outlined and several other investigations in line with the original purpose have been, and are now being, continuously carried on and will be published by the editor probably not long after the present volume leaves the press. We would add here that if the data which the author had before him, and now found in these pages, leaves doubt that a real *reversal* of sex was effected in the cases herein described, such doubt would seem to be wholly excluded by the results of the four years of additional study of this material by the editor, the studies having been

¹² It seems scarcely necessary to state that Whitman's generalizations upon infertility, longevity, etc., were made after an accounting of such external or incidental things as poor incubation, poor feeding, poor care, greater winter mortality (*of all* birds—the early and the late-hatched—which of itself would tend to make the birds of late season shorter-lived on the average than those hatched earlier) among pigeons, etc. The very full data of the tabulated breeding records amply demonstrate this.—EDITOR.

made specially to test this point and to learn something of the nature and hereditary basis of sex.

"The fertility of the crosses extends to the hybrids, but generally not with the full strength and constancy shown in the parent birds. In this respect, the generic (ring \times turtle) hybrids fall more or less below the specific hybrids, and in both classes the degrees in fertility descend with the degrees in relationship between the parent species.¹³ The hybrids are more often males than females."¹⁴

"Germs are as variable as the soma itself. A recent proof of this I find in the young of a pair of homers (Dec.-Jan. 1908-9). One of the young has juvenal wing-bars like the stock-dove (weakened), the other has feathers almost white and the bars are obsolete—only traces." (K 12)

It is clear then that the central feature of the author's extensive hybridization studies—the subject dealt with in this volume—is the demonstration of germs of several grades of genetic non-equivalence and these strung upon a line; concerning which line he has obtained some definite and illuminating information leading to the conclusion that germs subjected to certain procedures are forced to one or another level of hereditary and developmental power.

In the following summary the author has presented a situation respecting fertility which he had found to be largely typical of many crosses of pigeons, namely, lower fertility in the *very first egg* or eggs of the season; then a period of high fertility, followed by a prolonged period of much reduced fertility or of absolute infertility in late summer or autumn:

A male mourning-dove raised in 1897 was mated during the season of 1898 with a ring-dove, but hatched nothing. The same bird was mated in April 1899 with another ring-dove. This pair had egg and young as follows:

A 1. Apr. 23, 1899; no development.	A 1. May 29, 1900; no development. ¹⁵
A 2. Apr. 25, 1899; no development.	A 2. May 31, 1900; no development.
B 1. May 30; hatched.	♂B 1. June 16; hatched.
B 2. June 1; hatched.	♀B 2. June 18; hatched (no gonad).
♂C 1. June 30; hatched.	C 1. July 3; poor incubation.
♂C 2. July 2; hatched.	C 2. July 5; poor incubation.
♂D 1. Aug. 1; hatched.	♂D 1. July 12; hatched.
♂D 2. Aug. 3; hatched.	D 2. July 14; hatched.
E 1. Sept. 8; no development.	E 1. Aug. 18; no development.
E 2. Sept. 10; no development.	E 2. Aug. 20; hatched.
F 1. About Oct. 1; no development.	F 1. Oct. 6; no development.
F 2. About Oct. 3; no development.	F 2. Oct. 8; no development.
G 1. Oct. 31; no development.	G 1. Jan. ? 1901; no development.
G 2. Nov. 2; no development.	G 2. Jan. ? 1901; no development.

Here three successive pairs of eggs were hatched between June 14 and August 18. The male continued to sit faithfully until the first week in November. He began to sit

¹³ "In Plants, according to Swingle and Webber (1897, p. 388), *widely different families* never yield hybrids. *Distinct genera* usually yield no hybrids. *Distinct species* of same genus often yield hybrids. Cultivated races, or natural varieties, of same species generally yield hybrids." (A 1)

¹⁴ "See Buffon, vol. 3, p. 3, supplement. Meekel refers to this in vol. 1, p. 312. Davenport concludes (Inheritance in Poultry, Publication of the Carnegie Institution of Washington No. 52, 1906, p. 100) that "prepotency is as truly important in inheritance as dominance." This is certainly true in pigeons. The same author finds also that "the proportion of the two sexes in hybrids is normal. Among pigeon hybrids this does not hold." (K 12)

¹⁵ This second list is added by the editor from the author's data, for comparison. This record is complete in table 100. Only males are known from crosses of the mourning-dove and the ring-dove (a cross of subfamily rank).

in November, but soon lost interest. This male and female, although remarkably successful in fertilizing and hatching during the normal season, failed after August, *i.e.*, at the end of regular season for the mourning-dove. (R 11)

Fertility and the sexes, everywhere in the earlier chapters of this volume, occupy the center of interest, but these are interwoven with the following several topics, the data upon which must be presented as fully as is possible:

- (1) Decreased fertility associated with lateness of season.
- (2) Weak germs associated with lateness of season.
- (3) Femininity associated with lateness of season.
- (4) White color associated with lateness of season.
- (5) Association of extreme youth, old age, inbreeding and overwork, with weak germs, female sex, and white color.
- (6) The relative strength and sex tendencies of the two eggs of the pigeon's clutie.¹⁶
- (7) The nature of fertility, weak germs, sex, albinism.

Practically, it would prove difficult, however, and involve much repetition, to attempt a separation of the data at hand with a view to presentation under these several headings. Moreover, the nature of the data, having to do with associated or correlated phenomena, renders such a separate treatment nearly or quite impossible. We feel obliged, therefore, to present *seriatim* the large number of breeding records which have a common bearing on these questions, and to accompany these with some discussion when necessary. Some items can nevertheless be specially emphasized in the consideration of particular records; and part of the data can be reserved for later treatment (in later chapters) of one or two of the above-mentioned subjects. As elsewhere intimated, the results have been obtained by a close attention to the nature and product of *individual* birds, and indeed of *individual* eggs.¹⁷ It is therefore quite essential to an exposition of the results, or to the formation of a judgment upon them by others, that they be presented in a form—with a detail and completeness—hitherto unknown in the publications of studies in genetics.

¹⁶ The author has considered this point particularly *in crosses*, and in *wild species* of pigeons. See close of Chapter XIII for a fuller statement.—EDITOR.

¹⁷ Before undertaking an examination of the breeding records of the large numbers of groups of crosses it may be well to note that "infertility" proceeding from accidental or temporary sources such as poor care, cold, etc., have been very carefully recorded by the author, and such cases are fully designated in the tabulations of this volume. There are cases, too, in which eggs were laid by females after their mates ceased to copulate. These and similar circumstances were evidently closely followed, and the conclusions which were drawn upon the subject of fertility are most certainly not affected by the "infertility" traceable to such causes.—EDITOR.

CHAPTER IV.

JAPANESE TURTLE-DOVES CROSSED WITH A DISTANTLY RELATED AND WITH A CLOSELY RELATED SPECIES.¹

The present chapter and the three following ones deal with the breeding and crossing of the Japanese or Oriental turtle-dove. The data included bear upon several different subjects, but chiefly with "degree of fertility" in association with longevity and sex. The relation between "weak germs" and season, crowded reproduction, inbreeding, and "mutations" are touched upon at many points. All of these topics are met with in the present chapter, where the first purpose is to record the data for the fertility, sex-ratio, and longevity of the offspring of the three species concerned when individuals are mated (1) to their own kind, (2) to a related species, and (3) to an unrelated species.

Different individuals of the species *Turtur orientalis*, under even normal or usual conditions, bestow very different possibilities of length of life upon their offspring. When mated with their own species the strongest pairs of Japanese turtles should produce offspring with a life-term of perhaps 3 to 15 years or more. Data on this point will be found toward the conclusion of the chapter. When crosses are made, the "width of the cross" very measurably affects (in the widest crosses) the number of eggs that will hatch, and also the length of life and the sex of the resulting offspring. By "width of cross" is meant the degree of phylogenetic separation of the species used.² When a species closely related to *T. orientalis* is used as the other member of the cross, more of the eggs will hatch, the young will live longer, and the sex-ratio in the offspring will be more nearly that normal to a mating of two *T. orientalis* than when a species distantly related to *orientalis* forms the other member of the cross. The species most closely related to *T. orientalis* is the European turtle-dove (*Turtur turtur*), and the most widely separated species with which the Japanese turtle has been mated is the domestic pigeon. *Columba admista*, *C. affinis dom.*, *C. tabellaria*, and *C. gyrans* were the common pigeons most used. The external characteristics of the Japanese turtle-dove are well shown in pl. 1. The common pigeons are too well known to require special illustration or description here; one is shown with its hybrid mate in pl. 3, and several are figured in Volume I. There is no connected body of data to be presented on the length of life of the common pigeon, but it is generally known that they easily attain 5 to 15 years.

COMMON PIGEON \times JAPANESE TURTLE-DOVE.

Five female Japanese turtles were tested with 7 male common pigeons. They formed 8 different matings which will be individually described; but the tables which accompany these pages are relied upon to supply many points of information and to permit a closer view of the essential facts.

From the first mating (*admista* \times *orientalis*, 1) 16 eggs were tested (table 1). Four eggs showed no development; 3 produced embryos unable to complete develop-

¹ The textual statement of this chapter has been written by the editor; all of the tabulated breeding records used here are those of the author.

² The affinities and phylogeny of the pigeons are treated in Volume I of these works. A partial sketch of the classification has been given at the close of Chapter II of this volume.

ment, and one of these was strikingly abnormal, having rudimentary legs with only two front toes, and with abnormal nostril; 9 young were hatched. One lived long—nearly 10 years; 4 died in less than 2 weeks.

The second and third matings (*tabellaria* × *orientalis*, 12 and 31) supply 23 tests of value (table 2), though incubation was not perfect in 5 or 6 of these; 4 did not begin development (2 possibly from poor incubation); 7 developed, but failed to hatch (most of them from poor incubation); 12 hatched, 1 lived nearly 5 years, 2 others of uncertain life-term but probably of 2 to 4 years, while 9 died in less than 3 weeks after hatching; 1 of these latter birds had deformed legs.

A fourth pair (*tabellaria* × *orientalis*, 29) of more mature birds that were worked less vigorously at egg-production gave perceptibly better results (table 3). The term of life of their offspring is noticeably increased. It is nevertheless quite clear that the features common to a cross of widely separated species are present. Tests were made on 19 eggs; 2 did not begin development, 2 others developed but were deserted, embryos were produced in 4, 11 hatched. One of the offspring lived more than 6 years, while 4 others lived from 2 to 3 years; 4 died within 3 weeks of hatching, and 2 of these were deformed.

Pair 5 (*affinis* × *orientalis*, 2) yielded still better results. The female of this pair was remarkable for the high degree of fertility of her eggs in other matings also, and for having lived in captivity for more than 15 years. She was paired with three different common pigeons, and was later mated for a term of 7 years with a male of her own species. In the twelfth and thirteenth years of her captivity, and when mated to her son, she produced "mutant" offspring, noted at the end of this chapter and treated more fully in Chapter V. Of her fertility while mated with the first of the three common pigeons under consideration we may note that all of the 6 eggs tested were hatched (table 4), and that the life-term of the offspring was probably longer than has been observed in the preceding families. Here, too, where fertility and longevity are less narrowly limited, a female (?)—deformed, and having a very *rudimentary* ovary—is found among the offspring. Still another of this family—the clutch-mate² of the deformed female (?)—also had deformed legs and died two weeks after hatching. One of the hybrids from this cross is represented in pl. 35.

A male homer (*C. tabellaria*, 1) which will later be noted as a remarkably fertile bird (fertile with *St. risoria*) was given to the above *T. orientalis* female in the autumn immediately after the production of the last-mentioned series of fertile eggs. This pair (6) was then made to produce eggs as rapidly as possible. This gave the result best made clear by reference to table 4. The extreme end of the season yielded 5 eggs incapable of beginning development. Only 4 eggs hatched from 11 adequate tests; 1 of the young was deformed, and 1 full-term embryo was also probably deformed. From pair 7 (*C. affinis*? × *orientalis* 2) only 4 eggs were obtained; these immediately followed the "overwork" period of the preceding pair. Two were tested, though imperfectly; one produced an embryo, the other did not.

Pair 8 was formed two years later by mating this same female with an immature male (*C. admista*? R 1). The pair was overworked. They supplied 21 tests with

² The term "clutch" is applied to the two eggs laid at one nesting period. The second egg is laid 40 to 48 hours after the first. Particulars for the various species are given in Volume III.



Adult female Japanese turtle-dove, *Turtur orientalis*. $\times 0.8$. Toda del. The feathers have broad centers of black color; their edges are of lighter color, gray, bronze, or reddish.

only 5 hatched; 14 showed no development; 2 formed embryos. One of the young was alive at 2 years or age, and another escaped when 8 months old. The other 3 lived less than a month.

The sex of 16 offspring of this series of matings, involving *T. orientalis* in a cross of family rank, is known. Of these 14 were known to be males; possibly 2 were females, one having a very rudimentary ovary, the other copulated as a female (a very inadequate test of sex) and almost certainly produced no eggs, though it lived nearly 5 years.

The data on the fertility of the reciprocal cross are not very extensive, but indicate complete infertility. Three such pairs of ♂ *orientalis* × ♀ common pigeon gave 43 tests, all of which proved absolutely infertile. These wholly infertile tests are further analyzed as follows:

Orientalis (19) × gyrans (1903).....	Fam..	16.....(F 22)
Orientalis (1) × gyrans (1).....	Fam..	12.....(C 7/6)
Orientalis × domestica (black).....	Fam..	(15?)...(F 22)

FERTILITY TESTS OF HYBRIDS OF COMMON PIGEON × JAPANESE TURTLE-DOVE.

Three males from pairs 1, 5, and 8 described above were tested for fertility. Only one of these (A 1)—the one that probably lived longest and arose from the most fertile original cross (pair 5)—proved fertile. This male was mated back to a common pigeon;⁴ the restrictions upon the fertility and upon the life-term of offspring of this cross (pair 9) are notable and are presented fully in table 6.

An examination of the record makes it clear that though some development proceeds from some of the fertilizations of this pair, it is, in a very high percentage of cases, quite narrowly limited. There is a high percentage of eggs (28 of 59) showing no development whatever; 13 produced embryos only; 17 hatched, 1 or 2 of these requiring to be helped from the shell; 6 of those hatched died within 2 to 27 days. The length of life of 5 young is not known, but probably only 4 lived to maturity. This very bad record may have been somewhat influenced by the element of inbreeding, since the hybrid was mated to a probable half-sister; but that this is by no means the chief adverse factor is indicated by the fact that the short period during which an unrelated female (*C. affinis*) was used there was still less fertility—no trace of development in any of 5 eggs. A factor of more importance, perhaps, is that of overwork. This hybrid and his consorts were worked more rapidly, during much of this mating period, than is favorable for the production of strong germs. Nevertheless the main features of this mating record is clearly to be referred to the hybrid nature of the sire, as will become clear later when the fertility of hybrids from closely related species shall have been examined. The failure of germs to begin development, the limitations placed upon the development and upon the life-term of the offspring, all become more and more pronounced as the hybrids are derived from more distantly related species.

From this cross more of the second eggs of the clutch showed the less development of the pair—11 to 6. One female of this cross was of white color (color of her paternal and (?) maternal grandfather); two females had the color of the father, and one resembled the mother. One male was white, one was chequered, and one was black.

⁴ A female *C. livia* was also used during a short period; this pair proved entirely infertile.

The other matings of hybrids of this series tested absolutely infertile, and are as follows:

Domestica-orientalis (F 2) × domestica.....	.....	.....	6 (F 26)
Domestica-orientalis (A 1) × gyrans (T 1) .....	.....	.....	2 (F 24)
Admista-orientalis (F' 2) × gyrans.....	.....	.....	12 (G 18)

JAPANESE TURTLES CROSSED WITH EUROPEAN TURTLE-DOVES.

Four pairs of the two closely related species, *T. orientalis* and *T. turtur*, were mated and gave a result in striking contrast to that obtained by crossing *orientalis* with common pigeons. Reference may be made to pl. 2 in order to see how much *T. turtur* has in common with *T. orientalis*. In these crosses it will be found that practically all eggs hatch; that abnormal embryos or birds are not present; that the life-term of the offspring is longer than in the cross with common pigeons; that the resulting hybrids are fertile; and that males do not notably outnumber the females.

Pair 1 was composed of a male *turtur* and a female *orientalis*. 20 of their eggs were tested and 20 young were hatched; 5 of these lived more than 3 years and 1 is still alive at more than 10 years. The shortest terms of life are 51 and 59 days; these are, at the same time, the eggs laid latest in the year and at the end of a period of overwork at egg-production. Likewise the shortest lived bird of the preceding year was from the last egg of that year (see table 7).

Four years later the female of pair 1 was mated with another male of the European species. These birds, called pair 1a, produced 20 eggs, 12 of which were tested; of these 10 hatched, but the "last clutch" of the season failed even to begin development. Coincident with this diminution of fertility, as compared with other pairs, there is likewise a marked shortening of the life-term of the birds that were hatched; 1 or possibly 2 offspring lived 1 year and 5 months; 5 died at less than 5 months. From this mating, too, females predominate—5 females to 1 male.

Pairs 2 and 3, recorded in tables 8 and 9, supply data for the reciprocal cross. 6 eggs from pair 2 were tested; all hatched, and all lived longer than 2 years. When this same male was later mated to a *turtur* × *orientalis* hybrid (9) several eggs failed to hatch, and the several young lived from 1 week to 7 months (table 10). From pair 3 the 4 eggs obtained gave rise to 4 young, all with a life-term of 2 to 3 years.

The sex-ratio in these crosses is quite different from that observed in the common × Japanese matings. From the *turtur* × *orientalis* cross the sex is known of 21 birds—7 males and 14 females. This excess of females occurs principally during periods of forced or crowded reproduction. From the reciprocal cross 4 males and 2 females were obtained. All of the hybrids—male and female from the cross made in both directions—are fertile. The data establishing this fact will now be presented.

TURTUR HYBRIDS CROSSED INTER SE AND WITH PARENT SPECIES.

In the first cross of *T. turtur* and *T. orientalis* these species seem to be fully fertile. There is, perhaps, some evidence from the probably reduced longevity of the offspring which would warrant a qualification of the term "fully fertile." When the fertility of the hybrids themselves is tested there is then no question as to the reduction of fertilizing and developmental powers—or compatibilities—of their germs; and this diminution of fertility then exhibits itself not only in a still further limitation upon the life-term of the *F*₂ generation, but in the evident failure of many germs to begin development and in the early or late abortion of many promising beginnings of development.



- A. Adult European turtle-dove, *Turtur turtur*. $\times 0.6$. Toda del. Dark centers of feathers narrower and less prominent than in the Japanese turtle-dove (plate 1); the red edging is more prominent in *turtur*.
- B. Juvenile male Japanese turtle-dove, *T. orientalis* (56). From egg of 8-15-05; age 6 weeks. Hayashi del. Nov. 1905. $\times 0.5$. The juvenile color presents feathers with dark centers and light edges, as does the adult (plate 1), but the differentiation and the boundaries are here less distinct. The neck-mark shows only as rows of feathers.

This group of hybrids showed also ill-adjusted reproductive *instincts*. The records of 5 pairs of these hybrids, or of a hybrid mated to a parent form, are given herewith. In all of these there is a history, usually quite persistent, of "deserted" eggs or young. This desertion of the nest is more frequently met with in the hybrids than in either of the parent species. Soft-shelled eggs are noted in 2 of the 5 matings; a dwarf egg in 1. The meaning of these reproductive abnormalities is not clear, but their incidence in individuals or generations whose germ-cells are also "ill-adjusted" merits further consideration.⁵

A brother and sister from the ♂ *turtur* × ♀ *orientalis* cross were mated when a little less than 1 year old. This pair (5) produced 14 eggs during their first (immature) year. Table 11 shows the consistently poor results; 1 egg gave no embryo, 1 a weak embryo, 5 produced embryos but the eggs were deserted and were not given a complete test, 6 hatched, 1 lived but 10 days, while the remaining 5 all died between 1 month and 2½ months after hatching. During the following year the pair produced 11 eggs, of which 8 were tested; 2 failed to produce embryos and 6 were hatched; all except 1 lived 2½ to 5 months; the exception lived 22 months. The pair evidently produced stronger germs when 2 years old than when in their first year. The sex of 9 of the young is known—3 males and 6 females.

A sister to the birds of pair 5 just described was mated to a male of the *orientalis* × *turtur* cross. This pair (6) was more mature when mated, but persistent desertion of eggs (see table 12) permitted only 4 adequate tests of the 16 eggs produced during two years; 2 of these (and also 2 deserted ones) produced embryos, and 2 hatched. One of the latter was a male which lived 4½ months.

A brother to the male of pair 6 was tested when 1 year old with a pure Japanese female. From 8 tests (11 eggs) 3 young were hatched with life-terms of 3 days, 2 months, and 16 months. In their second, more mature, year they again yielded 11 eggs; of these 8 hatched and 3 were quite infertile. Three died early, 4 lived 3 to 8 months, and 1 is still alive at nearly 8 years (table 13). Two males and 3 females are known from the eggs of the second year. The better result from the more mature birds is obvious.

A male *orientalis* × *turtur* hybrid was mated when 1 year old to a $\frac{3}{4}$ *orientalis*- $\frac{1}{4}$ *turtur* hybrid hatched from the preceding pair (6). The result is a demonstration of still lower fertility and a still further restriction upon the life-term of offspring than pertains to either of the earlier crosses from which the two parents were produced. Table 14 indicates 11 tested eggs; of these 4 are known to have been absolutely infertile; 1 gave an embryo only. 6 eggs hatched, but the term of life of probably all of them was between 5 days and 2½ months (table 14). None of the hybrids from the *orientalis-turtur* crosses tested infertile.

The following cross is of unusual interest. A hybrid from two races of common pigeons was mated with a female *turtur* × *orientalis* hybrid. Here the two individuals finally crossed are widely separated forms, but in addition each parent is itself a hybrid from two closely related species or varieties (common pigeons). Attention may first be given to the fact that color in the offspring is here a sex-limited character, the males being dark, the females light in color. There is one apparent exception for each sex. The female that was not of light color was "dark

⁵ For treatment of several related topics see "The Reproductive Cycle," Vol. III of these works.

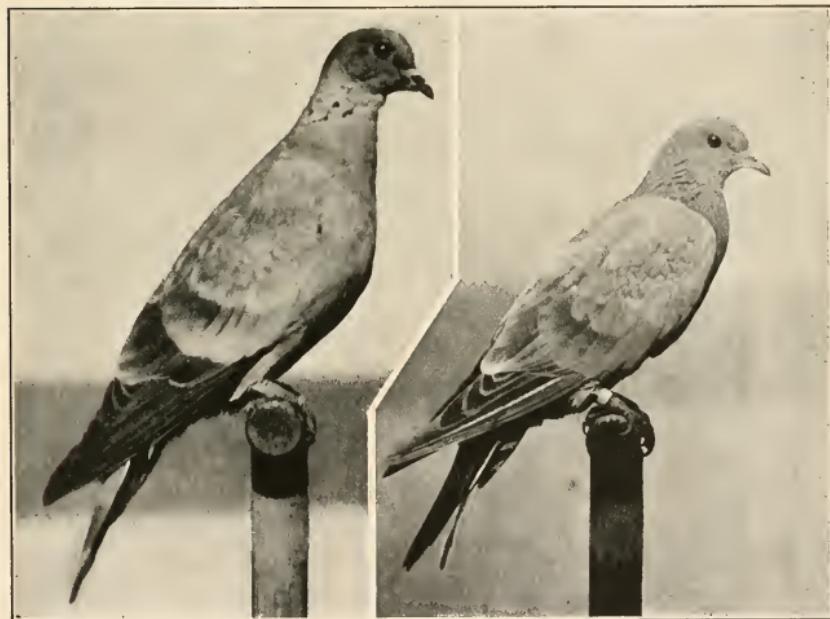
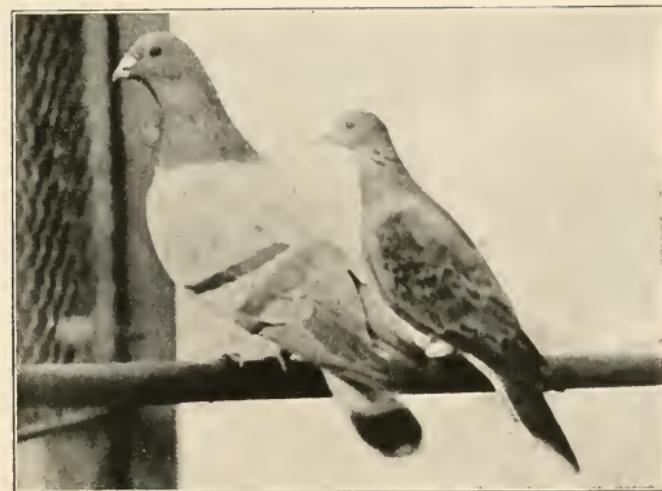
with patches of pure white," and was so remarkable as to be separately described later. The male listed as "to be of light color" died at 6 days, and it seems possible that this early prognosis of color was wrong. At any rate, the author later records (R 16) this cross as exhibiting sex-limited inheritance. It may be pointed out that this type of heredity in a cross between species of different *families* has not hitherto been reported. The two parents are shown in pl. 3; a darker male hybrid and one of the light females from this pair are also shown in the same plate.

The data (fully given in table 15) show that from this cross all of the 18 eggs of the first year were hatched—a very remarkable result in the light of what has been seen of the results of pure individuals of *Columba* crossed with pure individuals of *Turtur*. We meet here, too, the further interesting fact that though all of the eggs are capable of hatching, the term of life of the young is *limited to quite the same period* as were the offspring of pure *Columba* × pure *Turtur* (see tables 1, 2 and 3). This period for 11 young of the first year was 1 to 22 days after hatching, and the 6 hatches of the following year all fell within this same period. The life-term of birds from eggs laid in May of the first year forms a notable exception; 6 birds from the 6 eggs of this period produced birds that lived from several months to more than 3 years, and 1 male from this group is still alive at nearly 7 years. Immediately following this group, 1 young lived 64 days, and then the term of life again fell to a few days.

The abnormalities met with in those earlier (pure *Columba* × pure *Turtur*) crosses, moreover, promptly reappear in this record. There are three or probably four groups of such abnormalities. The first of these is the already familiar abnormal legs, these being short and directed backward in one individual. This bird came from the eleventh egg of the season, July 1; its clutch-mate sister of July 3 was also abnormal in that she bore only 10 rectrices (tail feathers), instead of the normal 12. This latter deficiency is shown in 3 other sisters, or in 4 of a total of 5 females which lived long enough to permit an examination of this portion of the plumage; and it is not without interest and significance to note that the reduction of these rectrices is quantitatively expressed, in order, by the numbers: 11, 10, 10, 9. And that this series (9 represents primaries *not* rectrices) runs from early in the season to later in the season, and thus corresponds also to the sliding scale of longevity already noted. Moreover, all of the *males* and the *earliest female* of this series have the normal number—12 tail feathers.

The third abnormality or group of abnormalities was borne by a bird hatched from the sixteenth egg of the season (August 22) and the second of the clutch. It had much "white" scattered over the body (see footnote to table 15), and there "was nothing in the ancestry to explain these flecks and patches of white." As a further expression of weakness this bird had only 9 primaries. It is probable that the second egg of the following clutch—the very last of the season—produced also a bird with abnormal plumage; its "down" was recorded as "almost whitish," but it died before anything further could be learned of it.

In several instances we shall again see the same thing that is evident here, namely, that deviations from the type present themselves most frequently in individuals hatched from "weakened" germs. Among the pigeons the factors producing these weakened germs are at least partially known, and a considerable part of the effort of this volume aims at the presentation of this information.



A. Adult male owl-homer hybrid No. 2 (to the left). Adult female *Turtur turtur* \times *T. orientalis* hybrid No. 8 (to the right). $\times 0.3$.

B. Hybrid male (C 2) from owl-homer hybrid \times *T. turtur* \times *T. orientalis* hybrid. Hatched May 3, 1908; photographed at 6 months. $\times 0.4$. Color gray-reddish on secondaries and long coverts. The medium coverts have marks of a bar. This is one of the larger hybrids.

C. Hybrid female (E 1) from owl \times homer hybrid \times *T. turtur* \times *T. orientalis* hybrid, May 28, 1908. Photographed at 5½ months. $\times 0.35$. Color light-gray; central marks of feathers weak. Chequering present, but weak, on the long coverts.

Enough is known of the history, nature, and causation of these deviations or "mutations," some of which have been shown to "breed true," to enable one to predict that they will arise only or almost exclusively from such weakened germs.

FERTILITY AND LONGEVITY IN PURE-BRED JAPANESE TURTLE-DOVES.

It remains to indicate the normal percentage of fertile eggs produced by *T. orientalis* when pairs of individuals of this species are mated together, and further, to supply data upon the sex and longevity of the offspring of these matings for comparison with the very limited life-terms noted particularly in crosses of this species with a distantly related one.

The presentation of the data in a complete and tabulated form will, moreover, serve two other necessary objects. First, these tables assist, as do others of this book, in a demonstration of the relation that exists between season of hatching and of longevity of the offspring, and the further facts of *individual* differences in the capacity of parents, due to age, health, overwork, etc., to produce strong germs. In the second place, many of the young whose origin is given in these tables are later studied extensively as parents; the all-important features of the germinal foundations from which they grew can be shown adequately, owing to the associations just noted, only by means of such tabulations. This holds especially true of the "mutations" which appear at the extreme end of the record; and these "mutations" become the subject-matter of the succeeding chapter.

The one breeding record available for *T. turtur* is presented at this point. It much resembles the records for *orientalis* which are to follow. Table 16 shows that of 9 eggs tested, 8 were hatched; there is no definite record for the other one. The shortest life-term is 4 months, and one of the young was alive and breeding at 51 months. The two longest-lived birds were from the second clutch of the season; the egg that probably failed to hatch, and the bird of shortest life-term, were from the last (fifth) clutch of the year, laid July 26-28; 3 males and 4 females are known from this family.

Especially complete records are available for the results of 4 of 5 matings in pure Japanese turtle-doves.⁶ From pair 1 there were 21 tests, and, as is shown in table 17, all were hatched; 2 eggs, the first pair of the second season, were poorly incubated, but both developed to hatching. Here again the young of longest life-term arose from early (not the "very earliest") eggs of the season; the birds from the last eggs died youngest. Neither the question of age nor of possible relationship of the two birds of pair 1 can be definitely answered; they were imported together and their short-lived offspring may be inbreds. That the term of life of their offspring is too short—is indeed a "time fuse" set at about 3 months—is apparent. The death of both the parents early in 1906 and the lameness of the sire indicate weakness and possibly old age as contributory causes of their weakened germs. 4 males and 4 females are known from this family.

The data for pair 2 are very incomplete (table 18). Eggs were obtained only from an unfavorable season of the year. The parents were imported together and may have been related. They were overworked. 6 of their 11 eggs were deserted, for 1 there is no record; probably 3 eggs produced embryos and 1 showed no development. Both parents died soon after these eggs were produced.

⁶ Matings involving inbreeding of Japanese turtles are specially considered in the next chapter.

The parents of pair 3 were certainly not closely related, probably not related at all. They were both long-lived, but the female of this pair died a few months after the close of the season recorded in table 18A. They were not overworked. 6 of their 7 eggs hatched; 1 showed no development. The long-lived offspring were from May and June. The first egg and the last egg hatched the shortest-lived young.

Pairs 4 and 5 were most adequately tested and are the matings of greatest interest. The same female was used in the two matings; the members of pair 4 were probably not related; in pair 5 the female of the former pair was mated with her son. This record covers a period of 8 years. A juvenal male offspring (56) from pair 4, from the third year of this mating, is shown in pl. 2. The most important feature of these two matings is the appearance of three "mutations" at the close of the period, when the dam was at least 12 to 14 years old and when inbred to her son. The distribution of sex, longevity, and fertility, as displayed in table 19, is also of much interest.

In a closer examination of these two matings we note:

(1) Two sexes arose from the same clutch in 14 cases; in 10 of these the first egg produced a male, in 4 cases the first hatched a female.

(2) In 9 of these same cases the bird from the first egg lived longer than its clutch-mate from the second egg; in 4 cases less long; in 1 this is unknown.

(3) Of the 9 long-lived birds, 7 are males, 2 are females; of the 4 short-lived birds from the first egg 2 are females.

(4) Two females hatched from individual clutches in 4 cases; in two of these the bird from the first of the clutch lived much the longer.

(5) Of 7 such pairs of males the birds from the first egg lived longer in 5 cases. Birds from the first egg therefore lived longer than their mates in 16 such cases, died earlier in 8, at the same time in 2; the data are insufficient in 5 cases.

(6) A tabulated summary of the longevity of offspring, fertility, and the sex-ratio corresponding to each of the 7 years this female (of pairs 4 and 5) was mated, is as follows:

Average age (14) yg. of 1903 = 42+	mo.7 eggs unhatched = 0 (in 19)	♂♂: 5♀
" " 12) " 1904 = 23+	" " = 1 (in 16) 7♂: 6♀	
" " 10) " 1905 = 18+	" " = 2 (in 14) 5♂: 4♀	
" " 8) " 1906 = 24-	" " = 1 (in 12) 5♂: 4♀	
" " 8) " 1907 = 18-	" " = 2 (in 14) 4♂: 4♀	

Inactive 1908; mated *with son*, 1909-10.

Average age (2) yg. of 1909 = 8½ mo.7	eggs unhatched = 1 (in 4) 1♂: 2♀	
" " (10) " 1910 = 26+	" " = 2 (in 8) 2♂: 3♀	3 "mutations"

The longest term of life (1903) coincides with the highest proportion of males and with the highest fertility; the very shortest term of life (1909) coincides with the maximum of infertility, the highest proportion of females, with very old age of the mother, and to inbreeding with an immature son.

(7) White color "mutations" occur only at the end of the series, when the female parent is quite old (12 to 14 years in captivity), when fertility is lowest, when the proportion of females is highest, when longevity is reduced, and when inbred to her son.

The question of the nature and breeding value of the color "mutations" which appear in this record, and of the effect of inbreeding of Japanese turtles, on the fertility, sex, longevity, and the general topic on "strength of germs," will be considered in the next chapter.

⁷ In these series which include one or more birds alive at the time of writing, a plus sign (+) is added to the average age (in months).

TABLE 1.

Pair 1.

σ^{σ} C. admista (Z); 1894 or 1895 (?) ; escaped ¹ 12/22/00; 6 + yr.			
♀ T. orientalis (I); imported 1897 (?) ; dead ¹ 3/1/98; ? yr.			
A. 8/4/97	relived; ² abnormal legs	dead 8/24/97	20 da. ³
A 1. 9/6	hatched	dead (trip) 9/29/97 .....	.23 da.
A 2. 9/8	hatched; light gray	dead 10/6/97 .....	.28 da.
B 1. 10/6; no development.			
B 2. 10/8; developed 14 to 15 day embryo.			
C 2. 10/23; developed to hatching; failed; legs rudimentary, etc. ⁴			
C 2. 10/25; hatched right leg imperfect; killed.			
σ^{σ} D 1. 11/5	hatched (like sire + red)	dead 12/7/97 .....	.32 da.
D 2. 11/7; no development.			
E 1. 11/16; no development.			
E 2. 11/18	hatched	dead (care?) 12/17/97 .....	.30 da.
F 1. 12/18; no development.			
σ^{σ} F 2. 12/20	hatched; infertile ⁵	alive 1/29/00 .....	.2 + yr.
G 1. 1/12/98	hatched	dead (care?) 1/29/98 .....	.17 da.
G 2. 1/14/98; nearly fully developed; failed.			
σ^{σ} H 1. 2/1	hatched	dead 11/15/07	9 yr. 10 mo. (F 29)
H 2. 2/3; disturbed.			

¹ In this, and in most of the numerous succeeding tables of this volume, the age and length of life of both parents and offspring are included in the tables. A bird used as a parent has the date of hatching placed immediately after its name and number; the date of its death follows, and the length of its life-term is placed to the extreme right of the table. The date of the death of the various offspring of the record and the length of their life-terms are arranged in columns beneath the equivalent data for the parents.—EDITOR.

² That is, egg was opened by the observer at or after the time to hatch.—EDITOR.

³ The age is usually reckoned from time the egg is laid; this bird marked "20 da." lived but 4 days after hatching.—ED.

⁴ "Only two front toes, and the right nostril also abnormal."

⁵ "Head speckled with white, elsewhere much white."

TABLE 2.

Pair 2.

σ^{σ} C. tabellaria (1903); killed 9/15/05; 2 + yr.			
♀ T. orientalis (12); 5/26/03; dead 6/17/05; 2 yr., 21 da.			
A 1. 4/10/04	hatched	dead 5/6/04 (had food?) .....	.26 da.
A 2. 4/12/04	hatched	dead 5/7/04 (had food?) .....	.25 da.
σ^{σ} B 1. 4/19	1	hatched, no other record	(?1 month to 4 years?)
B 2. 4/21; failed to hatch, possibly neglect or cold.			
C 1. 4/30; no development, possibly cold.		D 1. 5/9; developed, not hatched; possibly injured.	
C 2. 5/2; no development, possibly cold.		D 2. 5/11; developed, not hatched; possibly injured.	
E 1. 5/28	2	hatched, no other record.	
E 2. 5/30; hatched late, failed to compete for food; killed 6/25/04.			
F 1. 6/12; no development.			
σ^{σ} F 2. 6/14	3	dead 5/29/00 .....	.4 yrs., 11 mo., 12 da.
G 1. 7/14	hatched	dead 8/4/04 (food?) .....	.21 da.
G 2. 7/16	hatched, deformed legs; 8/3/04 (killed) .....		.18+ da.
H 1. 9/2	hatched	dead 10/2/04 (food?) .....	.30 da.
H 2. 9/4	hatched	dead 10/9/04 "no clear reason" .....	.35 da.
I 1. 3/9/05; deserted.		K 1. 4/14; deserted.	
I 2. 3/11; deserted.		K 2. 4/16; deserted.	
J 1. 3/24 ⁶ ; one developed, neglected.		L 1. 4/23; developed, deserted.	
J 2. 3/26 ⁷		L 2. 4/25; developed, deserted.	
M 1. 5/16 ⁸ ; one, probably M 1, hatched "strong bird" died 6/16/05 .....			.30 da.
M 2. 5/18 ⁹ other egg did not hatch.			

Pair 3.

♀ T. orientalis (31); 7/9/04; 3/21/06; given to above σ^{σ} June 19, 1905.

N 1. 8/15/05	hatched	dead 9/24/05	1 mo., 9 da. (F 22, A 10)
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TABLE 3.

Pair 4.

 σ^3 C. tabellaria (2); (stray bird, 1903?); no record of death.♀ T. orientalis (29); ancestry unknown; (not "29, young of 1 \times 1"); date of death not known.

A 1. 5/29/05.....	hatched.....	died very young.....	(?) 20 da.
A 2. 5/31/05; no development.			
B 1. 6/13.....	hatched.....	died at 7-14 days..... deformed, asymmetry. (?) 26 da.	
B 2. 6/15.....	hatched.....	died at 7-14 days.....	(?) 26 da.
σ^3 C 1. 7/14.....	4 R.....	dead 2/1/11-11/3/14.....	6+ yrs.
σ^3 C 2. 7/16.....	4 L.....	dead 4/18/08.....	2 yr., 9 mo.
D 1. 8/15.....	5.....	dead 11/11/07.....	2 yrs. 3 mo.
D 2. 8/17; no development.			
E 1. 10/10.....	6.....	no later record; probably short-lived.....	? 2 mo. to 1 yr.
E 2. 10/12; nearly hatched.			
F 1. 3/2/06; deserted.		G 1. 3/24; thin-shelled, broken.	
F 2. 3/4/06; deserted.		G 2. 3/26; thin-shelled, broken.	
H 1. 4/4.....	7.....	dead 2/5/08.....	1 yr., 10 mo.
H 2. 4/6; developed a little.			
I. 5/3; developed, deserted.			
J 1. 5/26; no record; almost certainly not hatched.			
J 2. 5/28.....	8.....	7/29/06.....	2 mo.
K 1. 6/16; failed to hatch.			
K 2. 6/18; failed to hatch.			

(Birds idle during this period at Woods Hole.)

σ^3 L 1. 9/16.....	9.....	12/27/09.....	3 yr., 3½ mo.
L 2. 9/18; stunted legs.....		10/11/06.....	1 mo. (F 22)

TABLE 4.

Pair 5.

 σ^3 C. affinis¹ domestica (3); about 3/1/97; killed 9/26/97.

♀ T. orientalis (2); imported 5/24/97; dead 11/17/12; 15+ yrs.

σ^3 A 1. 8/18/97.....	hatched|one, called A 1, <i>fertile</i> ; accident 4/30/02.....	.56+ mo.
σ^3 A 2. 8/20/97.....	hatched|one died 2/28/98.....	6 mo., 10 da.
? ♀ B 1. 8/27.....	killed Jan. 1899 (legs deformed; ovary very rudimentary).....	17+ mo.
B 2. 8/29.....	hatched, legs deformed.....	dead 9/26/97..... 29 da.
C 1. 9/6; hatched, starved.		D. 9/17/97; some development, broken.
C 2. 9/8; hatched, starved.		

(See pl. 35 for the appearance of these hybrids.)

Pair 6.

 σ^3 C. tubellaria (1) "At least two years old when obtained 2/7/97"; put here 10/17/97; removed 1/16/98; killed 11/7/02.

A 1. 10/17/97; no development; incubation bad.

A 2. 10/19/97; no development; incubation bad.

B 1. 11/9; hatched; no later record.

B 2. 11/11; pricked shell, failed; probably an abnormal embryo.

σ^3 C 1. 11/21.....	hatched.....	escaped 5/25/98.....	7+ mo.
C 2. 11/23.....	hatched, deformed legs.....	dead 12/10/97.....	17 da.
D 1. 12/4; no development.			
? D 2. 12/6.....	hatched; copulated 1898, built nests, but no eggs (apparently functioned as a ♀ when mated with sire).		

E 1. 12/16; no development.

E 2. 12/18; no development.

F 1. 12/30; no development.

F 2. 1/1/98; no development.

G 1. 1/8; broken.

G 2. 1/10; no development.

Pair 7.

 σ^3 Common dove (2); age unknown, given 1/18/98.

A 1. 1/23/98; thin shell, broken.

A 2. 1/25/98; thin shell, broken.

B 1. 2/1¹; incubation imperfect; one egg developed but did not hatch.²

(F 20, A 14)

B 2. 2/3/

¹ White fantail in the ancestry of this bird.² "Female No. 2 deserted all eggs given to replace clutches C to G inclusive. Since the male nested faithfully it may be that these latter eggs did not have adequate opportunity to be fertilized." No further record of any matings, or eggs, of this bird (♀ 2) until 1900.—EDITOR.

TABLE 5.

Pair 8.

δ^a Common pigeon (R 1) (gray w. dark bars); 8/12/99-7/15/02; 25 mo. (admista?).
 φ T. orientalis (2); imported 5/24/97; 11/7 12; 15 + yrs.

A 1. 3/29/00; no development.	C 1. 4/19; failed to hatch.
A 2. 3/31/00; hatched; died at one week.	C 2. 4/21; thin shell, broken.
B. 4/8; no development.	D. 5/2; no development.
E 1. 5/27; no development.	
E 2. 5/29.....dark.....	7/2/00.....1 mo., 3 da,
F 1. 6/15; no development.	
δ^a F 2. 6/17.....hatched, infertile; alive.....	5/20/02.....23 mo.
G 1. 7/10; no development.	J 1. 5/20/01; no development.
G 2. 7/12; no development.	J 2. 5/22/01; no development.
H 1. 8/3; no development.	K 1. 6/15; no development.
H 2. 8/5; no development.	K 2. 6/17; no development.
I 1. 10/5; no development. ¹	L 1. 7/6; 8 to 10 day embryo. ²
δ^a I 2. 10/7; hatched; "died young."	δ^a L 2. 7/8; hatched; escaped 2/28/02. (G 4)

¹ Old birds separated from Sept. 1900 till May 15, 1901.² In 1902 female T. orientalis (2) refused to mate with male T. orientalis (2).

TABLE 6.

Pair 9.

δ^a C. affinis dom. \times orient. (A 1); 8/19/97; accident 4/30/02; 56+ mo.
 φ Common pigeon (black).

The father of the bird here used as sire was partly white fantail.

The sire of this female is also the sire of her mate (A 1); i.e., these two birds probably half brother and sister. This female had laid 8 other eggs during the season before the following:

φ C 1. 8/6/99; hatched; white.	G 1. 11/10; some development.
φ C 2. 8/8/99; no development.	G 2. 11/12; no development or slightest trace development.
D 1. 8/23; opened prematurely; live embryo.	H 1. 12/25; dead 1/18/00; "could not learn sex; well cared for."
D 2. 8/25; no development.	H 2. 12/27; no development.
E 1. 9/7; developed about 7 days.	
δ^a E 2. 9/9; like C. livia; ¹ "fell dead suddenly" 4/14/01.	
F 1. 10/23; no development.	R 1. 8/16; no development.
F 2. 10/25; no development.	δ^a R 2. 8/18; hatched; white; accident, 5/24/01, "a fine bird and probably fertile."

I 1. 1/29/00; hatched; black.	S 1. 9/30; hatched; dead at 9 days (exposure)?
I 2. 1/31/00; chequered; trace red.	S 2. 10/1; hatched; black; dead 12/20/00. Copulation prevented 2 to 4 days before laying T 1 and T 2.
J 1. 3/7; some development.	T 1. 9/30 no development.
J 2. 3/9; no development.	T 2. 10/2; no development.
K 1. 3/30; dead 17 day embryo.	δ^a U 1. 10/23; hatched; dead at 27 days (overfeeding?).
K 2. 4/1; no development.	U 2. 10/25; hatched; color leaden gray, like C. annas.
L 1. 4/12; some development.	V 1. 11/27; no development.
L 2. 4/14; no development.	V 2. 11/29; "developed fully; why it did not hatch I am unable to say. I opened it two days after it was due and found the bird dead but fully ready to hatch, the yolk having been almost wholly taken up. The sire now given to a chequered rock-dove that has not been mated for two years (since she came from England)." (F 26)
M 1. 4/30; dead 17 day embryo.	This mating is given in the next part of this table.
M 2. 5/2; helped from shell; complexion of sire; dead at 2 days.	
N 1. 6/1; no development.	
N 2. 6/3; some development.	
δ^a O 1. 6/18; hatched; dead 7/21/00. ²	
δ^a O 2. 6/20; hatched; dead 9/1/00 (canker); "testicle very small."	
Q 1. 7/20; hatched; "color of sire;" dead 11/8'00; green discharge.	
P 2. 7/22; no development.	
Q 1. 8/3; hatched; dead at 6 days.	
Q 2. 8/5; 7 to 10 day embryo.	

¹ "Color of this bird, when adult, is a chequered ground gray, with spots black, closely like C. livia but plainly shading towards the condition of spots in the male grandparent. Cooing like that of common pigeon, but not so loud. Delivery and quality of voice were quite like the common pigeon. . . . Too, the bird showed in its attitudes and behavior some slight and hard-to-describe differences. The testes were enormous in size, 6/8 inches long by 5/16 inch in shortest diameter."

² "O 1 died July 21, age two weeks; short and somewhat irregular breathing noticed 2 or 3 days before death; bird was large and apparently healthy; do not know what the trouble was; perhaps some organic weakness of its hybrid constitution."

INHERITANCE, FERTILITY, AND SEX IN PIGEONS.

TABLE 6 (*continued*).

σ^{σ} Affinis dom. \times orient. hyb. (A 1) (con.); killed 4/30/02.
 φ C. affinis (chequered); here till 1/22/01. (This φ suddenly unable to fly after laying egg B 1)

A 1. 12/31/00; no development.	C 1. 2/19; no development.
A 2. 1/2/01; no development.	C 2. 2/21; no development.
B 1. 1/18/01; thin shell.	D. 4/1; no record.
B 2. 1/20/01; thin shell.	
♀ Common pigeon (black) reunited with this σ^{σ} (see record for 1900, above) 4/10/01.	
W 1. 4/14; no development.	BB 1. 9/12/02; thin shell.
W 2. 4/15; no development.	BB 2. 9/14/02; no development.
X 1. 5/1; 7 to 10 day embryo.	CC 1. 1/14/03; no development.
σ^{σ} X 2. 5/3; matured; "black like mother."	CC 2. 1/16/03; no development.
Y 1. 6/1; no development.	DD 1. 2/17; no development.
Y 2. 6/3; no development.	DD 2. 2/19; no development.
Z 1. 7/1; developed several days.	EE 1. 3/15; 12 to 14 day embryo.
Z 2. 7/3; no development.	EE 2. 3/17; two-thirds size first egg; prob. no development.
AA 1. 7/27; no development.	FF 1. 4/20; prob. no development.
φ AA 2. 7/29; dead 3/24/03; blackish. ³	FF 2. 4/22; prob. no development. (F 26, A 13)

³ "This female had a very rudimentary ovary."

TABLE 7.

Pair 1.

σ^{σ} T. turtur (19); 7/1/1903; 9/22/05; 2 yr. 2 mo. 21 da.
 φ T. orientalis (11); 5/12/03; 12/7/10; 7 yr. 7 mo. 16 da.

A 1. 5/1/04; broken.						
A 2. 5/3/04; broken.						
φ B 1. 5/11.....1.....cold.....	5/9/05.....					1 yr.
φ B 2. 5. 13.....2.....	3/31/07.....					2 yr. 10 mo. 18 da.
φ C 1. 5/25.....3.....	5/23/05.....					1 yr.
C 2. 5/27.....accident.....	6/12/04.....					
σ^{σ} D 1. 6/4.....4.....	2/27/08.....					3 yr. 8 mo. 8 da.
σ^{σ} D 2. 6/6.....5.....alive.....	8/1/14.....					10+ yr.
E 1. 6/21.....lice-killed.....	7/20/04.....					
E 2. 6/23.....lice-killed.....	7/19/04.....					
φ F 1. 7. 25.....6.....	10/10/07.....					3 yr. 2 mo. 15 da.
σ^{σ} F 2. 7. 27.....7.....cold.....	4/25/05.....					9 mo.
φ G 1. 4/2/05.....8.....(see pl. 3)	5/13/10.....					5 yr. 1 mo. 11 da.
φ G 2. 4/4. 05.....9.....	11/18/07.....					2 yr. 7 mo. 14 da.
H 1. 4/11; broken.						
H 2. 4/13?; broken.						
φ I 1. 4. 19.....10.....	6/25/08.....					3 yr. 2 mo. 6 da.
12. 4/21; broken.						
J 1. 4/29.....11.....	8/4/05.....					3 mo. 6 da.
φ J 2. 5/1.....12.....	4/5/06.....					11 mo. 6 da.
K 1. 5/19; deserted.						
K 2. 5/21; deserted.						
L 1. 6/6.....13.....killed.....	6/27/05.....					
L 2. 6/8; no record.						
σ^{σ} M 1. 6/21.....14.....	1/25/06.....					7 mo.
σ^{σ} M 2. 6/23.....15.....	4/14/07.....					1 yr. 9 mo. 21 da.
σ^{σ} N 1. 7/29.....16.....	9/20/05.....					1 mo. 21 da.
φ N 2. 7. 31.....17.....	9/26/05.....					1 mo. 29 da. (F 8, A 10)

TABLE 7A.

Pair 1a.

σ^{σ} T. turtur 1908 (?); exact date of birth and death unknown.

φ T. orientalis (11); (same φ as in pair 1 above).

φ A 1. 6/20/09.....18.....	9/5/09.....					2 mo. 15 da.
φ A 2. 6/22/09.....19.....	9/2/09.....					2 mo. 10 da.
φ B 1. 7/10.....20.....	10/28/09.....					3 mo. 18 da.
B 2. 7/12.....21.....	11/25/09.....					4 mo. 13 da.
φ C 1. 7/19.....22.....	12/30/10.....					1 yr. 5 mo. 11 da.
C 2. 7/21.....23; starved.						

TABLE 7A (*continued*).

D 1. 4/5/10; no record. ¹	F 1. 5/24/10; no record.
D 2. 4/7/10; no record.	F 2. 5/26/10; no record.
E 1. 5/19; no record.	G 1. 6/8; no record.
E 2. 5/21; no record	G 2. 6/10; no record.
♂ H 1. 6/19.....24.....	2/10/11.....
H 2. 6/21.....25.....	hatched; no later record.
♀ I 1. 7/28.....26.....	12/21/10.....
I 2. 7/30.....27.....	died bet. 2/15/11-11/4/13.
J 1. 9/8; no development. ²	
J 2. 9/10; no development.	

¹ It seems probable, in view of the statement in note 2 below, and in the complete absence of record, that these eggs were not tested for fertility.—EDITOR.

² "Note that this failure to develop must be attributed to infertility of the male or female or both; and that fertility usually reaches a full halt in or by the end of August. The last fertile eggs were laid July 28 and 30, and the young were raised and so far doing well."

TABLE 8.

Pair 2.

♂ T. orientalis (10); 4/6/03; 10/10/07; 4 yr. 6 mo. 4 da.
♀ T. turtur (2); 11/21/05; more than 2 yrs.

(Together 1904 without mating).

A 1. 4/9/05; deserted.	D 1. 5/14; broken.
A 2. 4/11/05; deserted.	D 2. 5/16; broken.
B 1. 4/20; no record.	E 1. 5/23; deserted.
B 2. 4/22; no record.	E 2. 5/25; deserted.
C 1. 5/1; killed.	
C 2. 5/3; killed.	
F 1. 6/10.....1.....	certainly dead before 2/15/11.....
♂ F 2. 6/12.....2.....	10/16/07.....
G 1. 7/14.....3.....	certainly dead before 2/15/11.....
G 2. 7/16.....4.....	certainly dead before 2/15/11.....
♂ H 1. 8/26.....5.....	11/19/07.....
♀ H 2. 8/28.....6.....	10/4/07.....

TABLE 9.

Pair 3.

♂ T. orientalis (78); 4/19/07; 10/26/10; 3 yr. 6 mo. 7 da.
♀ T. turtur (1); imported 1902-3; lived more than 6 yrs.
♂ A 1. 7/12/08.....7.....
A 2. 7/14/08.....8.....
certainly more than 2½ yrs. and certainly less than 5½ yrs.
probably 1 or 2 years and certainly less than 2½ years.
♀ B 1. 7/29.....9.....
8/13/10.....
♂ B 2. 7/31.....10.....
6/30/11.....

TABLE 10.

Pair 4.

♂ T. orientalis (10); 4/6/03; 10/10/07; 4 yr. 6 mo. 4 da.
♀ T. turtur × T. orient. (9); 4/4/05-11/18/07; 2 yr. 7 mo. 14 da.

A 1. 5/1/06; developed, broken.	11/4/06.....	6 mo. 1 da.
♀ A 2. 5/3/06.....	S/15/06.....	3 mo. 6 da.
♂ B 1. 5/9.....	gray (see description).....	29 da.
B 2. 5/11.....	6/10/06.....	
C 1. 5/18; soft shell, deserted.	D 1. 6/7; hatched, no record.	
C 2. 5/20; soft shell, deserted.	D 2. 6/9; hatched, no record.	
E 1. 3/15/07; deserted, hatched, not fed.		23 da.
E 2. 3/17/07; deserted, hatched, dead 4/9/07.....		
F 1. 3/23; deserted, hatched, thrown from nest 4/9/07.		
F 2. 3/25; deserted, hatched, not fed, died 4/8/07.....		
♀ G 1. 4/2.....	11/7/07.....	7 mo. 5 da.
G 2. 4/4; did not hatch.		
♂ H 1. 4/16.....	8/10/07.....	3 mo. 24 da.
H 2. 4/18; apparently did not hatch.		
♂ I 1. 4/25.....	7/20/07.....	2 mo. 25 da.
I 2. 4/27; deserted; no development (cold?)		
J 1. 5/11; deserted, no development.		
J 2. 5/13; deserted, no development.		

(F 21)

TABLE 11.

Pair 5.

σ^3 Turtur \times orient. (1); brother; 6/4/04-2/27/08; 3 yr. 8 mo. 7 da.	
φ Turtur \times orient. (2); sister; 5/13/04-3/31/07; 2 yr. 10 mo. 18 da.	
A 1. 4/1/05; some development, deserted.	C. 4/25; some development, deserted.
A 2. 4/3/05; some development, deserted.	
B. 4/16; removed.	D 1. 5/3; some development, deserted.
E 1. 5/27; deserted	D 2. 5/5; some development, deserted.
E 2. 5/29; deserted	one hatched, died 10 days later (sour crop); other some development, but not hatched
F 1. 6/6.	....., dead 9/12/05. 3 mo. 6 da.
σ^3 F 2. 6/8.	....., dead 9/1/05. 2 mo. 23 da.
G 1. 7/8.	....., dead 8/29/05. 1 mo. 21 da.
G 2. 7/10; did not develop.	
φ H 1. 7/19.	....., dead 9/5/05. 1 mo. 16 da.
φ H 2. 7/21.	....., dead 9/4/05. 1 mo. 13 da.
I 1. 4/4/06; no record.	
φ I 2. 4/6/06.	....., dead 9/26/06. 5 mo. 23 da.
J 1. 4/17; no record.	
J 2. 4/19; on ground broken.	
σ^3 K 1. 4/25.	....., dead 9/20/06. 4 mo. 25 da.
K 2. 4/27; did not develop.	
φ L 1. 5/4.	....., 9/28/06. 4 mo. 24 da.
L 2. 5/6; did not develop.	
φ M. 6/2.	....., dead 4/13/08. 22 mo. 11 da.
φ N 1. 7/5.	....., dead 10/3/06. 2 mo. 28 da.
σ^3 N 2. 7/7.	....., dead 10/18/06. 3 mo. 11 da. (F 18)

TABLE 12.

Pair 6.

σ^3 Orient. \times turtur (5); 8/26/05; 11/19/07; 2 yr. 2 mo. 24 da.	
φ Turtur \times orient. (6); 7/25/04; 10/10/07; 3 yr. 3+ mo.	
A 1. 5/23/06; deserted.	B 1. 6/5; deserted.
A 2. 5/25/06; deserted.	B 2. 6/7; deserted.
σ^3 D 1. 4/2/07.	....., 8/27/07. 4 mo. 25 da.
D 2. 4/4/07; developed, failed to hatch.	
E 1. 4/9; deserted.	G 1. 5/9 or 5/10; killed (young) by sire.
E 2. 4/11; deserted.	G 2. 5/11 or 5/12; failed.
F 1. 5/4; deserted.	H 1. 5/23; soft shell, broken.
F 2. 5/6; deserted.	H 2. 5/25; soft shell, broken.

TABLE 13.

Pair 7.

σ^3 T. orient. \times T. turtur (2); 6/12/05; 10/16/07; 2 yr. 4 mo. 4 da.	
φ T. orient. (11); 5/13/03; 12/7/10; 7 yr. 7+ mo.	
A 1. 4/30/06; hatched; died at 2 or 3 days.	
A 2. 5/2/06; did not develop.	
B 1. 5/11; deserted.	D. 6/18/06; dwarf egg, 18.5 by 14.5 mm. (this period at Woods Hole).
B 2. 5/13; deserted.	
C 1. 5/23; no results.	E 1. 8/5; failed to hatch.
C 2. 5/25; no results.	E 2. 8/7; failed to hatch.
F 1. 9/10.	....., 1/13/08. 1 yr. 4 mo. 3 da.
F 2. 9/12.	....., 11/16/06. 2 mo. 4 da.
G 1. 3/30/07; deserted, hatched; no later record; probably died early.	
φ G 2. 4/1/07.	....., deserted; alive 8/1/14. 7+ yr.
σ^3 H 1. 4/13.	....., deserted. 7/22/07. 3 mo. 9 da.
H 2. 4/15.	....., deserted. 5/5/07. 20 da.
I 1. 4/26; deserted, after a week; no development.	
I 2. 4/28; deserted, after a week; no development.	
σ^3 J 1. 5/13.	....., 8/13/07. 3 mo.
J 2. 5/15; no development.	
φ K. 6/2.	....., hatched. 8/28/08. 8 mo. 6 da.
φ L 1. 7/2.	....., hatched. 12/8/07. 5 mo. 6 da.
L 2. hatched, no later record; probably died early.	(F 21)

TABLE 14.

Pair 8.

σ^{α} Orient. \times turtur (10); 7/31/08; 6/30/11; 2 yr. 11 mo.		
φ Orient. \times turtur (2) \times orient. (11) (G 2); 4/1/07; alive 8 1, 14; 7+ yr.		
A 1. 4/22/09; deserted, no development.	B 1. 5/13; deserted, egg not examined.	
A 2. 4/24/09; deserted, no development.	B 2. 5/15; deserted, egg not examined.	
C 1. 5/25; developed, but failed to hatch.		
σ^{α} C 2. 5/27.....	8/24/09.....	2 mo. 27 da.
D 1. 7/9; not fed; died early.		
D 2. 7/11; did not develop.		
φ E 1. 7/25.....	8/18/09.....	24 da.
E 2. 7/27; did not develop.		
F 1. 8/6.....	canker.....	9/4/09.....
F 2. 8/8.....	canker.....	9/4/09.....
G 1. No record.		
G 2. No record.		
H. 7/1/10; hatched; no later record.		(F 12)

TABLE 15.

Pair 9.

 σ^{α} Owl \times homer hyb. (2); (July 1907); sire = silver, dam = thin black (see pl. 3). φ Turtur \times orient. hyb. (8); (April 1905); 5/13/10; color, interm. (see pl. 3). σ^{α} A 1. 4/12/08; hatched; light; dead at 10 days (canker). σ^{α} A 2. 4/14/08; hatched; dark; dead at 10 days.

B 1. 4/22; hatched; dead at 2 days.

B 2. 4/24; hatched; dark; dead at 14 days.

 σ^{α} C 1. 5/1..... hatched..... pale dark..... alive 2/7/11..... 3+ yr. σ^{α} C 2. 5/3..... hatched..... dark..... alive 1/1/15..... 7+ yr. (see pl. 3) σ^{α} D 1. 5/16..... hatched..... dusky..... alive 11/17/08..... 6+ mo. φ D 2. 5/18..... hatched..... lighter..... alive 11/17/08..... 6+ mo. φ E 1. 5/28..... hatched..... lighter (11 rectrices)..... died before 2/15/11..... (see pl. 3) φ E 2. 5/30..... hatched..... light (10 rectrices)..... died after 2/15/11..... 3+ yr. σ^{α} F 1. 7/1; hatched; (killed at 3 days); short legs!; down was whitish yellow. σ^{α} F 2. 7/3; hatched; pale blond-gray; dead at 64 days; only 10 tail feathers. σ^{α} G 1. 7/19; hatched; to be dark; dead at 8 days. σ^{α} G 2. 7/21; hatched; to be light; dead at 6 days. σ^{α} H 1. 8/20; hatched; dark; dead at 22 days (exposure?). σ^{α} H 2. 8/22; hatched; dark; ¹ dead at 19 days. σ^{α} I 1. 9/3; hatched; down pale yellow; dead at 1 day (accident?). σ^{α} I 2. 9/5; hatched; (exposed); "down almost whitish;" probably died very early.

Birds separated 12/1/08 to 2/3/09.

J 1. 2/13/09; hatched; down pale yellow; dead at 3 days (overfed?).

J 2. 2/15/09; hatched; darker than J 1; dead at 7 days (deserted).

K 1. 3/12; one pricked shell; other some development

L 1. 3/28; hatched; not fed.

K 2. 3/14; (poor incubation).

L 2. 3/30; some development (poor incubation).

M 1. 4/7; did not develop.

M 2. 4/9; hatched; light; dead at 10 days.

N 1. 5/6; no development.

N 2. 5/8; hatched, overfed, dead at few days.

O 1. 6/1; did not hatch.

O 2. 6/3; hatched (overfed?), dead at few days.

P 1. 7/20; no development.

P 2. 7/22; hatched; ring-like down; killed at 9 days (had canker).

Q. 8/19; no record.

(F 17, K 2)

¹ The color of this bird is dark, about the same as H 1, but quite remarkable. It has 'white flecks' scattered quite thickly over the whole crown of the head, and also two white feathers in rump (otherwise dark grayish brown). Only 9 primaries. One under tail covert (middle) white; rest gray. Nothing in ancestry to account for it. The first ease this season, and note that it hatched in September." (R 16)

TABLE 16.

σ^{α} A 1. 4/19/99.....	12/1/99.....	7 mo. 12 da.
A 2. 4/21/99; dwarf egg; 25 by 19 mm., no development, probably not a complete yolk.		
φ B 1. 4/29..... hatched..... alive 7/23/03.....	4+ yr.	
B 2. 5/1..... hatched..... alive 7/1/01.....	2+ yr.	
φ C 1. 5/28.....	12/14/99.....	6 mo. 17 da.
σ^{α} C 2. 5/30.....	12/25/99.....	6 mo. 25 da.
σ^{α} D 1. 6/26.....	11/26/99.....	5 mo.
φ D 2. 6/28.....	12/29/99.....	6 mo. 1 da.
φ E 1. 7/26.....	11/27/99.....	4 mo. 1 da.
E 2. 7/28; apparently did not hatch.		(C7/1)

TABLE 17.

σ^{α} T. orientalis (1); lame; imported April 1903; 4/22/06; 48+ mo.		
φ T. orientalis (1); imported April 1903; 3/23/06; 48+ mo.		
A 1. 4/21/04..... 26; dead 5/15/04 (food?).		
A 2. 4/23/04..... 27; dead 5/15/04 (food?).		
B 1. 5/20..... 26..... dead 9/12/04.....	3 mo. 22 da.	
B 2. 5/22..... 27; dead 6/12/04 (food?).		
C 1. 6/16; egg broken.		
σ^{α} C 2. 6/18..... 29..... dead (fighting) 2/16/09.....	4 yr. 7 mo. 28 da.	
D 1. 7/12..... 32..... dead 10/26/04.....	3 mo. 14 da.	
D 2. 7/14..... 33; lice-killed, early.		
σ^{α} E 1. 8/3..... 33..... dead 11/19/04.....	3 mo. 16 da.	
σ^{α} E 2. 8/5..... 34..... dead 11/29/04.....	3 mo. 24 da.	
φ F 1. 8/26..... 37..... dead 11/24/04.....	2 mo. 25 da.	
φ F 2. 8/28..... 38..... dead 12/9/04.....	3 mo. 11 da.	
G 1. 9/29; hatched; ¹ dead 10/2/04; "died within month."		
G 2. 10/1; hatched; dead 10/2/04; "died within month."		

H 1. 3/7/05; developed to hatching (incubation poor?).

H 2. 3/9/05; developed to hatching (incubation poor?).

K 1. 3/31..... 39..... dead 8/16/05.....

K 2. 4/2; died very young.

 σ^{α} L 1. 4/28..... 42..... dead 7/18/05.....

L 2. 4/30..... 43..... dead 8/6/05.....

M 1. 5/25..... 44..... dead 8/19/05.....

M 2. 5/27..... 45..... dead 7/30/05.....

 φ N 1. 7/1..... 51..... dead 10/12/05..... σ^{α} N 2. 7/3..... 52..... dead 9/24/05.....¹" Eggs of 1904 were usually deserted by the male."

TABLE 18.

Pair 2.

 σ^{α} T. orientalis (3); imported 5/6/03; 10/11/05; (age?); 2½+ yr. φ T. orientalis (3); imported 5/6/03; 3/19/06; (age?); 3+ yr.A 1. 1/25/05; some development. C 1. 3/6; failed. E 1. 4/14; deserted.
A 2. 1/27/05; no development. C 2. 3/8; failed. E 2. 4/16; deserted.B 1. 2/19; deserted. D 1. 3/26; deserted. F. 4/25; no record.
B 2. 2/21; deserted. D 2. 3/28; deserted.

(F 28)

TABLE 18A.

Pair 3.

 σ^{α} T. orientalis (0); ("an old bird" in 1905); 10/28/08; 8+ yr. (probably 10 to 12 yr.) φ T. orientalis (11); 5/13/03; 12/7/10; 7 yr. 7 mo.

A 1. 4/18/08..... 85; no later record; probably died early.

A 2. 4/20/08; no development.

B. 5/19..... 86..... dead..... 6/23/11.....

3 yr. 1 mo. 4 da.

 φ C 1. 6/23..... 88..... dead..... 4/23/13.....

4 yr. 10 mo.

 φ C 2. 6/25..... 89..... (killed, tuberculosis)..... 5/24/09.....

11 mo.

D 1. 8/4..... accident..... 8/21/08.....

 σ^{α} D 2. 8/6..... 90..... dead..... 3/5/09.....

7 mo.

(F 28)

TABLE 19.

Pair 4.

σ^A T. orientalis (2); imported early 1900; 3/12/08; S+ yrs.			
♀ T. orientalis (2); imported early 1897; 11/17/12; 15+ yrs.			
σ^A A 1. 4/6/03.....10.....dead (?).....	10/10/07.....		.4 yr. 6 mo. 4 da.
A 2. 4/8/03.....	4/24/03.....		.16 da.
♀ B 1. 5/12{one .....11.....disappeared.....	12/?/10.....		.7 yr. 7+ mo.
♀ B 2. 5/14{other broken.			
♀ C 1. 5/26.....12.....dead.....	6/17/05.....		.2 yr. 21 da.
♀ C 2. 5/28.....13.....dead.....	3/4/06.....		.2 yr. 9 mo. 6 da.
σ^D D 1. 7/6.....14.....dead.....	6/3/09.....		.5 yr. 10 mo. 27 da.
σ^D D 2. 7/8.....15.....dead.....	8/4/05.....		.2 yr. 26 da.
σ^E E 1. 8/3.....16.....dead.....	7/10/05.....		.1 yr. 11 mo. 7 da.
♀ E 2. 8/5.....17.....dead.....	11/28/08.....		.5 yr. 3 mo. 17 da.
σ^F F 1. 8/17.....18.....dead.....	3/17/06.....		.2 yr. 7+ mo. ¹
σ^F F 2. 8/19.....19.....dead.....	9/28/06.....		.3 yr. 1 mo. 9 da.
G 1. 9/9; soft shell (after trip).			
σ^G G 2. 9/11.....20.....dead.....	11/24/04.....		.1 yr. 2 mo. 13 da.
♀ H 1. 9/18.....21.....dead.....	7/12/08.....		.4 yr. 9 mo. 24+ da. ¹
♂ H 2. 9/20.....22.....dead.....	6/19/06.....		.2 yr. 9+ mo. ¹
J 1. 11/1; deserted; hatched; apparently died very young.			
J 2. 11/3; deserted; hatched; apparently died very young.			
K. 12/7; deserted (cold); unhatched.			
♀ L 1. 3/7/04.....23; dead, certainly lived longer than L 2.			
L 2. 3/9/04.....not hatched, but fully developed.....			.14 da.
σ^M M 1. 4/8.....24.....dead.....	11/1/06.....		.2 yr. 6 mo. 23 da.
σ^M M 2. 4/10.....25.....dead.....	(?) before M 1.		
N 1. 5/11; dead; (cold) 5/31/04.			
N 2. 5/13; dead; (cold) 5/31/04.			
σ^O O 1. 6/7.....27.....dead.....	3/27/06.....		.1 yr. 9 mo. 20 da.
σ^O O 2. 6/9.....28.....dead.....	10/5/04.....		.3 mo. 25 da.
♀ P 1. 7/7.....30.....dead.....	3/?/06.....		.1 yr. 8 mo.
♀ P 2. 7/9.....31.....dead.....	3/21/06.....		.1 yr. 8 mo. 12 da.
σ^Q Q 1. 8/13.....35.....alive.....	8/1/14.....		.10+ yr.
♀ Q 2. 8/15.....36.....dead.....	11/8/04.....		.2 mo. 23 da.
♀ R 1. 9/15.....36.....dead.....	11/6/05.....		.1 yr. 1 mo. 21 da.
♀ R 2. 9/17.....37.....dead.....	12/26/04.....		.3 mo. 9 da.
σ^S S 1. 10/31.....37.....dead.....	12/25/07.....		.3 yr. 1 mo. 24 da.
σ^S S 2. 11/2.....38.....dead.....	7/30/05.....		.9 mo. 3 da.

Winter of 1904-5 this pair kept without chance to nest.

T 1. 3/4/05{one hatched; no later record; one began

T 2. 3/6/05} development.

U. 4/2; deserted.

V. 4/24; deserted.

σ^W W 1. 4/28.....40.....dead.....	5/1/13.....		.8 yr. 3 da.
♀ W 2. 4/30.....41.....dead.....	8/11/05.....		.3 mo. 11 da.
σ^X X 1. 6/1.....46.....dead.....	9/18/05.....		.3 mo. 17 da.
σ^X X 2. 6/3.....47.....dead.....	2/11/08.....		.2 yr. 8 mo. 9 da.
♀ Y 1. 7/9.....48.....dead.....	11/28/05.....		.4 mo. 19 da.
♀ Y 2. 7/11.....49.....dead.....	9/29/05.....		.2 mo. 18 da.
σ^Z Z 1. 8/15.....56.....alive.....	11/8/05 (see pl. 2).		
σ^Z Z 2. 8/17.....57.....(killed?).....	4/18/07.....		.1 yr. 8 mo. 1 da.
♀ AA 1. 9/29.....58.....dead.....	12/20/05.....		.2 mo. 21 da.
AA 2. 10/1.....59.....dead.....	11/7/05.....		.1 mo. 15? (da.)

TABLE I9 (*continued*).

BB 1. 3/8/06; large embryo.				
BB 2. 3/10/06.....59.....	hatched; probably lived a few days only.			
♂CC 1. 3/25.....59.....	dead.....	8/20/09.....		3 yr. 4 mo. 25 da.
♀CC 2. 3/27.....60.....	dead.....	(?) before ? CC 1.		
DD 1. 5/1.....61.....	dead.....	7/21/06.....		2 mo. 20 da.
DD 2. 5/3.....63.....	dead.....	8/17/06.....		3 mo. 14 da.
♂EE 1. 6/6.....66.....	alive.....	7/7/07.....		1+ yr.
♀EE 2. 6/8.....67.....	dead.....	12/19/06.....		6 mo. 11 da. ²
♀FF 1. 7/15.....68.....	dead.....	certainly before 7/1/11.		
♂FF 2. 7/17.....69.....	alive.....	8/1/14.....		.8+ yr.
♂GG 1. 9/5.....70.....	dead.....	12/20/07.....		1 yr. 3 mo. 15 da.
♀GG 2. 9/7.....71.....	dead.....	4/8/08.....		1 yr. 7 mo. 3 da.
♂HH 1. 2/25/07.....74.....	dead.....	10/21/07.....		7 mo. 26 da.
♀HH 2. 2/27/07.....75.....	dead.....	4/9/07.....		1 mo. 12 da.
♂II 1. 3/17.....76.....	stolen.....	8/12/12.....		(5+ yr.)
II 2. 3/19.....77; dead early bad? care?				
♂JJ 1. 4/19.....78.....	dead.....	10/26/10.....		3 yr. 6 mo. 7 da.
♀JJ 2. 4/21.....79.....	dead.....	5/19/08.....		1 yr. 28 da.
KK 1. 5/27.....81.....	dead; no record.			
KK 2. 5/29.....82.....	dead; (trip) 6/7/07.			
LL 1. 7/7.....82; no data.				
♀LL 2. 7/9.....83.....	dead.....	5/20/08.....		10 mo. 11 da.
♀MM 1. 9/5.....84.....	dead.....	2/8/08.....		5 mo. 3 da.
♂MM 2. 9/7.....85.....	dead.....	1/31/08.....		4 mo. 24 da.
NN 1. 1/27/08; deserted eggs.				
NN 2. 1/29/08; deserted eggs.				(F 28)

♂ T. orientalis (2) died 3/12/08.

♀ T. orientalis (2) given another ♂; remained inactive during 1908.³*Pair 5.*

♂ T. orient. (69); 7/17/06; alive 8/1/16; 8+ yr.; son and dam.

♀ A 1. 8/15/09; one..95.....whitened....."mutant".....dead 10/14/09.....2 mo. (see pl. 4)
A 2. 8/17/09; other egg produced nothing.♂B 1. 9/6.....96; "dark, about normal"; dead before B 2 (?)
♀ B 2. 9/8.....97....."dark, about normal".....11/23/10.....1 yr. 2 mo. 15 da.C 1. 4/2/10.....98.....whitened....."mutant".....dead 7/9/10.....3 mo. 7 da. (see pl. 6)
C 2. 4/4/10; unhatched.♀ D 1. 6/4.....99.....(normal color).....alive 8/1/14.....4+ yr.
D 2. 6/6; unhatched.♀ E 1. 7/23.....104.....(normal color).....dead 1/28/11.....6 mo. 5 da.
♂E 2. 7/25.....105.....(about normal color).....alive 8/1/14.....4+ yr.♂F 1. 9/7.....108.....whitened!....."mutant".....dead 3/8/13.....2 yr. 6 mo. (see pl. 7)
♀ F 2. 9/9.....109.....normal.....dead 9/3/12.....2 yr. (F 28)² Left eye blind.³ In 1911 and 1912 this female (No. 2) refused to mate with male white rings. After September 3, 1912, she was with a fairly mature male *T. orientalis* (452) but with no result. She died November 17, 1912.—EDITOR.

CHAPTER V.

MUTATION, FERTILITY, AND LONGEVITY IN INBRED JAPANESE TURTLE-DOVES.¹

At the end of the preceding chapter the long and remarkable breeding record of a female Japanese turtle-dove (*T. orientalis*, 2) was completely presented in the form of tables. That record, together with another closely associated with it, may now be fully discussed. This turtle-dove was kept in captivity for more than 15 years after her importation from Japan. In the twelfth and fifteenth years of this period she produced no eggs, and in the thirteenth and fourteenth years only 4 and 8 eggs respectively. During other years, including mating periods with common pigeons, from 12 to 20 eggs were laid per year. The few eggs of the thirteenth and fourteenth years were fertilized by a son; one-fourth of these eggs were infertile and 3 of the 9 eggs that hatched gave "mutant" young with whitened plumage. That this bird and her (earlier) mate, both taken wild in Japan, were quite pure *T. orientalis* is beyond question. They are both shown in pl. 6. Even a slight contamination with any species whatever, except possibly *T. turtur* of Europe, would have been easily detected in the birds themselves, while a quite uniform and very numerous progeny during many previous years strongly attest the purity of both parents. Finally, the "mutants" themselves are wholly unlike any other species of the genus *Turtur*, and equally unlike any related genera. These "mutants" are further considered and illustrated in the present chapter. Data dealing with the successful breeding of one of them is herewith given,² and the fertility and longevity records of inbred, non-inbred, and out-crossed relatives of these "mutants" are also presented.

THE JAPANESE TURTLE-DOVE MUTANTS OF 1909 AND 1910.

It is notable that the three "mutants" under consideration arose from a quite old female when mated with her son, and that two of the three striking variants arose from the *very first* egg of each year of the two years' duration of the mating. The third arose from the *last* clutch of eggs which this female ever laid, and this clutch was produced at the extreme end of the season, in September. These "mutants" bear, in order of their production, the numbers 95, 98, and 108.

The general appearance of these three is shown in a series of illustrations. No. 95 is figured in two plates: the live bird, together with plucked, expanded tail feathers (better to show the extent of the "whitening") in pl. 4; alongside a normal *T. orientalis* (94) of similar age in pl. 4; with its second growth of tail feathers, and expanded at the time of its death in pl. 5. The expanded tail and wing of a normal (94) to compare with the preceding is supplied in pl. 6. These illustrations show: (1) the degree of whitening attained in this "mutant"; (2) that a slight advance toward the normal darker color was attained by this bird in the second tail plumage; (3) that the (very) dark centers of the body

¹ The editor is responsible for the textual statement of this entire chapter and for the tabulated breeding records after 1910.

² These data, together with those on fertility and longevity, were supplied almost entirely by the editor, 1911 to 1915.

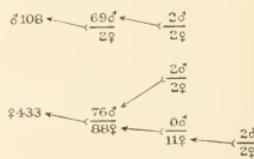
and wing coverts are particularly affected with white; and (4) that the uniformly dark feathers, such as primaries, secondaries, and rectrices, are more or less uniformly grayed or whitened.

In pl. 6 the extent of the variation of the second "mutant" (No. 98) is shown along with the two parents. It will be seen that this bird is more strongly whitened than was the preceding, but somewhat less so than the succeeding and final "mutant." This second variant, like the first, was short-lived, and no further history or illustrations of it are available.

The last and most interesting of these "mutants" (No. 108) is shown at two years of age in pl. 7. It will be observed that this final "mutant" was perhaps the most striking variant of the series, and that the variant state had maintained its exhibition throughout various molting periods. The nearly white tail and the absolute displacement by white of the typical dark centers of the individual feathers are well shown. This bird was perhaps less wild, and notably more quiet, than any individual of this species that the editor has observed.

THE BREEDING OF MUTANT NO. 108.

Only No. 108 of these birds lived to maturity, and it only therefore was available for breeding tests. This bird proved to be a male, but refused to mate during 1911. In 1912 it mated with an immature relative (No. 433, hatched August 2, 1911). The relationship of these birds is completely given in the accompanying sketch or diagram. The chief interest in breeding No. 108 lies, of course, in determining whether the bird is a real mutant, *i.e.*, whether the marked somatic aberrations from the type pertain also to its germs. The illustration already referred to shows how strikingly this bird differed from the parent species. We elsewhere (legend of pl. 7) record Dr. Whitman's interpretation of this marked "mutation" as the outcome of a "weakened germ"—weakness associated with extreme age of the dam and inbreeding.



The result of mating this "mutant" with the pure Japanese turtle (433) mentioned above is shown in table 20, and is of the greatest interest in connection with the questions of the heritability of the variation, of the effect of season, overwork, and inbreeding in "weakening" germs.

It will be seen that from this pair 11 young were hatched, and lived long enough to admit of their classification as normal or "mutant." Of these, 6 were normal

EXPLANATION OF PLATE 4.

A. Expanded tail of normal Japanese turtle-dove, *Turtur orientalis*, No. 94, of similar age with "mutant" No. 95.

B. "Mutant" Japanese turtle-dove No. 95 and normal No. 94. Of similar age; photographed together, Sept. 17, 1909, to show contrast.

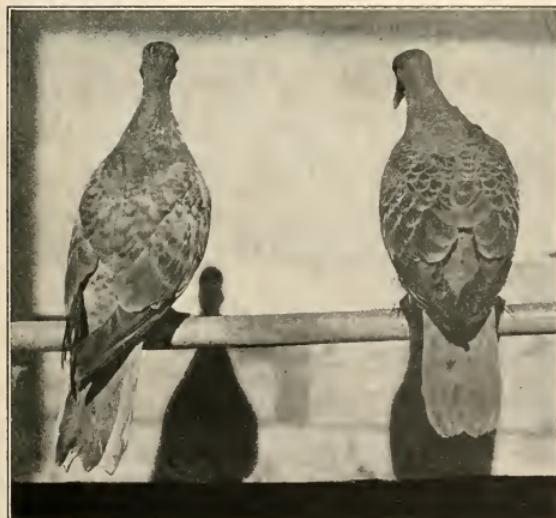
No. 95 is much whitened in coverts, tail, neck-marks, and, in fact throughout the entire plumage. The dam of this bird is now (Sept. 1909) at least 13 years old. She was imported in 1897, and at that time must have been one or more years old. The old age of the dam and the mating with her son accounts for the very light color of the young.

C. Profile view of "mutant" No. 95.

This bird was the first to appear of three "mutants" of *T. orientalis*. It was the least striking color variant of the three. It developed from an egg of Aug. 15, 1909. Photographed, Sept. 17, 1909. For pedigree see table 19.



A



B

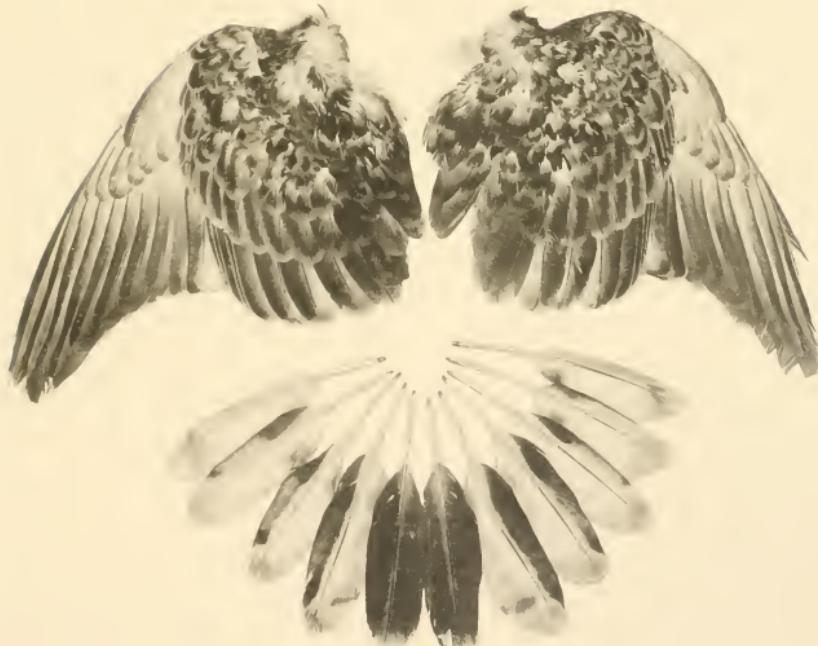


C

- A. Expanded tail of normal Japanese turtle-dove, *Turtur orientalis* No. 94, of similar age with "mutant" No. 95.
B. "Mutant" No. 95 and normal No. 94, Japanese turtle-doves of similar age.
C. Profile view of "mutant" No. 95. This was the first to appear of three "mutants" of *T. orientalis*. It was the least striking color variant of the three. It developed from an egg of Aug. 15, 1909. Photographed Sept. 17, 1909.



A



B

- A. Expanded tail-feathers of Japanese turtle-dove, *T. orientalis*, "mutant" female No. 95; plucked and mounted Sept. 20, 1909.
- B. Expanded wings and tail of Japanese turtle-dove "mutant" No. 95, at time of death, Oct. 14, 1909. The replacement of the dark centers of the wing and body coverts with white is well shown. The normally dark primaries and rectrices are here shown more or less uniformly grayed or whitened. The second growth of rectrices, shown expanded in the lower figure, have probably become slightly darker than in the first feathers, shown in fig. A.

in their early plumages and 5 were abnormal—abnormal in the direction of their mutational male parent—and the last 2 most decidedly like their “mutant” father. Further, the normal offspring arose from the earlier eggs of the season—the first 5 and the seventh eggs producing the normals. The 5 mutants were from the last 6 eggs permitting a decision, while the last 4 birds of the season were all “mutational,” the last pair most strikingly of all. The first “mutant,” the sixth egg from the last, was the least decisively mutational of all. Thus from the first of the season to late season this series of offspring exhibited the characters under examination in essentially the following order: normality, slightly mutational, more mutational, most mutational. Photographs of 8 of these young, the 5 mutants and 3 normals, are shown in pl. 7. All of these young, and the parents as well, were photographed on the same day, September 29, 1912.

It would seem, therefore: (1) that the male parent is a “true mutation,” having given the breeding test; (2) that early in the season the “mutation” is recessive to the normal, but at the end of the season is dominant to the normal; and (3) that a “graduated increase of dominance” is indicated by the lesser amount of white in the earlier as compared with the greater amount of white in the later offspring.

The situation is, of course, not what one would expect on the basis of the mutation theory and of Mendelism, but in such terms as are used under (1) and (2) above it might be described, if one should feel obliged, even in the face of difficulties, to cling still to “qualitative” interpretations of heredity phenomena. And, if one had closed his note-book in September or October 1912 and were oblivious to facts which deal with the history and longevity of offspring and of parents, and with the “strength” of germs as affected by consanguinity, season, and overwork at reproduction, one would have occasion to learn little of the nature and basis of these phenomena of inheritance.

With these latter data before us, however, we perceive that a truer description of this inheritance embraces little of hypothetical factorial elaboration and symbolism. When these two weak birds (the sire lived 30 months, the dam 28 months) produced their strongest germs, known from other studies to be from the earlier part of the season, apparently normal (but weak and short-lived) offspring were produced. The later, still weaker germs reproduced the striking abnormalities of the “mutant” father, and for the same general reason that these same abnormalities were originally produced in him, namely, that the level of developmental strength has been lowered—the potency of the germ-plasm shifted. That, however, a special reason, namely, the weak “mutant” condition of the father, is a prominent “explanatory” feature of the ready and consistent attainment of this weakened “mutant” condition of his offspring, can not be doubted. In this male the general developmental power and the specific power to produce certain parts of the color pattern were subnormal, and under conditions which are otherwise known to reduce the developmental level of germs the germs of this pair were easily, quickly, and consistently thrown into the exhibition of a similar low level of developmental strength; and this low level of color-pattern has, moreover, been found only in the immediate group to which the father belonged and in his offspring.

Moreover, a quite complete explanation of the situation involved here can not be given without attention also to the later history of the mother of this group.

The eggs which produced these "mutant" young were at the same time her last in life, though she lived more than 15 months after their production, and was then killed only by rather exceptional exposure. Very probably, however, she would have laid other eggs if she had been able to gain a perch and copulate. These things she was unable to do because in the late summer of 1912, *at the close of the overwork incident to the production of the series of eggs now under discussion*, she was unable adequately to renew her flight and tail feathers. Indeed, she remained permanently quite unable to renew more than a fraction of her plumage; at the time of death she was provided with very few body coverts and most other feathers were stunted and incomplete. It will thus be seen that the mother of this group of young was plainly a weaker organism at the extreme end of the season, when the dominance of the father's mutational characteristics became complete. The general weakness of the two parents no doubt coöperated in additional defects, abnormalities, and weakness which obtained in the entire series, but which, like the "mutational" character, were accentuated at the very end of the series.

But if some shall incline to assume that a germinal basis—a basis of genetic significance—is not involved in this instance and that these features might have been purely somatic in their nature, such assumptions may be brought to face the following further facts:

(1) The two most strikingly mutant young—the very last of the season—had "club feet" (in addition to the whitened mutational plumage), and one of these

EXPLANATION OF PLATE 7.

A. Figure on left: Japanese turtle "mutant" No. 108 and mate No. 433.

These are the parents of the other birds shown on this plate. The whitened "mutant" parent is shown to the left; the normal mate to the right. All birds of this plate photographed Sept. 29, 1912. "No. 108 was hatched Sept. 22, 1910. On Oct. 12, it is found that the dark centers of the juvenal feathers are replaced by white! The bird is a close copy of No. 98, and whitened for the same reason—the old age of the dam and *inbreeding*. Photographed in full juvenal plumage Nov. 25, 1910." (The photographs taken Nov. 25, 1910, proved unsuitable for reproduction; they served, however, to show that the later plumages of this bird were not perceptibly different from the first plumage.—Ed.)

Middle figure: One of the earlier normal offspring (891) of the above pair. The coloration was quite normal. Before death, however, the plumage of this bird showed a decided tendency to whiten.

Figure on right: The earliest of the young (826) of this series which was photographed. The bird was photographed in strong light, but the coloration was perfectly normal.

B. The first two partial "mutants" and an intervening normal young from the parents shown under A.

Figure on left: Male No. 879 with whitened tail-feathers, and with otherwise normal coloration. This was the second partial "mutant."

Middle figure: Female No. 880 with normal coloration throughout. In last plumage preceding death, however, there appeared several whitened feathers.

Figure on right: Female No. 891 with whitened tail and some gray and white in flight feathers. This was the third partial "mutant" of the series.

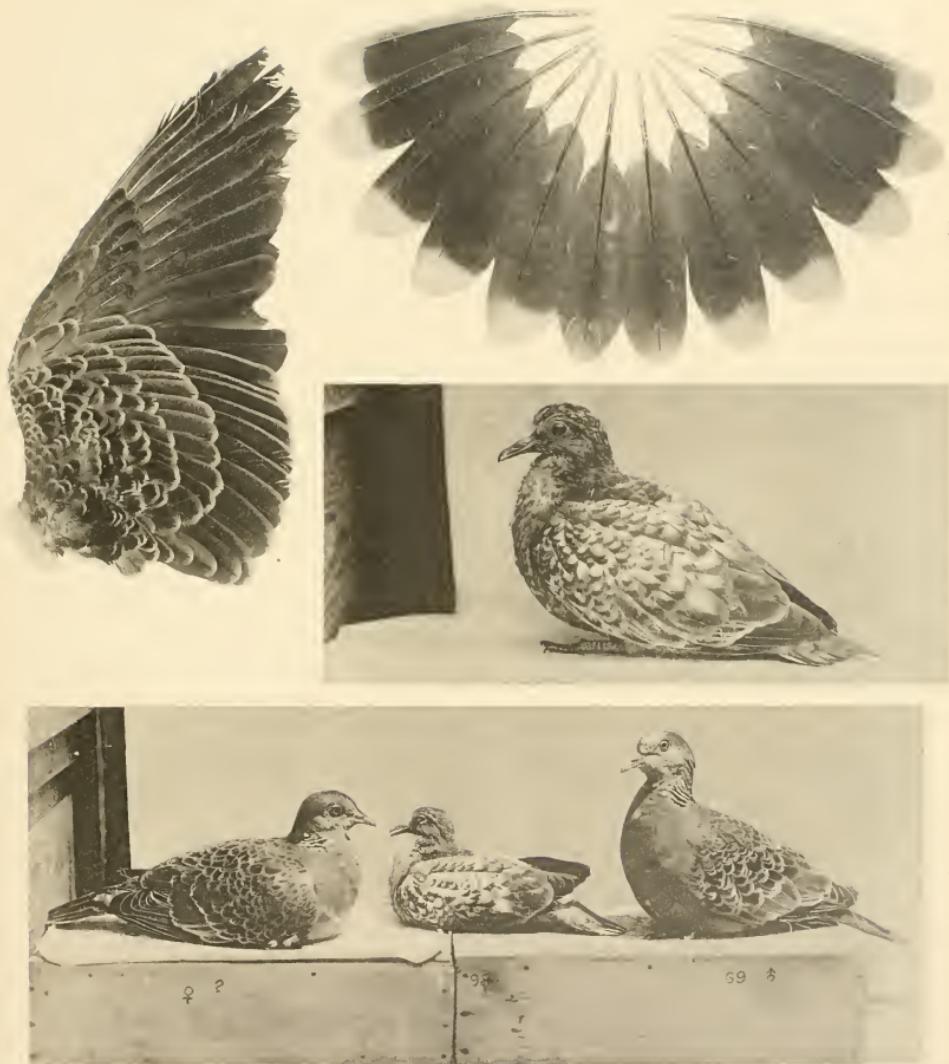
C. The last three "mutant" offspring of "mutant" No. 108 and normal No. 433.

Figure on left: Female No. 874; the fourth partial "mutant" of the season. Not only the tail, but some primaries, secondaries, and tertials were here whitened.

Middle figure: Male No. 859; one of the last pair of "mutants;" from the extreme end of the season. This bird has a white tail; mostly gray to white primaries, secondaries, tertials, and body coverts generally. Whole aspect extremely light. The feathering, particularly the primaries, was deficient in first and in later plumages. The bird had a "club foot" (the left).

Figure on right: No. 801 (sex ?); last "mutant;" nest-mate of above bird and quite similar to it in color and feathering. It also had "club feet" (one of which is shown in the illustration) and but a single kidney.

For the origin of the several young shown on this plate see table 20.



A, B. Wing and expanded tail of a normal Japanese turtle-dove, *T. orientalis*, No. 94 (4 weeks 4 days old). For comparison with pl. 5.

C, D. Japanese turtle-dove "mutant" No. 98 (second "mutant"), with parents, male *T. orientalis* (69) and female *T. orientalis* (2). From egg of April 2, 1910. Photographed May 20, 1910. The extent of white in the young and the perfect normality of the visible characters of the parents are shown. No. 98 is like No. 95, but considerably whiter. The juvenal feathers have the reddish edge followed by a thin border of black, the center being white. This "mutant" died July 9, 1910, with some of its adult feathers already in place; in these feathers the thin border of black has been perceptibly widened, while the center of the feather remains white or very light gray. The dam seems in fairly good health but rather heavy in motion, especially in flight. She flies up to her nest—about 7 feet—regularly, however, and often attains it by a nearly vertical flight.

A



B



A. Figure on left: Japanese turtle "mutant" No. 108 and mate No. 433. These are the parents of the other birds shown on this plate. The whitened "mutant" parent is shown to the left; the normal mate to the right.

B. The first two partial "mutants" and an intervening normal young from the parents noted above.
C. The last three "mutant" offspring of "mutant" No. 108 and normal No. 433.

birds was found at autopsy to have but a *single kidney*; such phenomena of development are inconceivable on any other ground than that the "germinal bases" of these characters were modified. These several germinal modifications were all associated in precisely the two most strikingly "mutant" young.

(2) The entire family of about 17 young (including embryos) show a significantly restricted term of life, demonstrating that gametes of reduced potency were being generally produced; furthermore, at least 4 eggs tested absolutely infertile.

(3) The mutational features here, like most mutations hitherto observed, involve the *loss* of characters.

(4) That the white mutational mark was not an adventitious somatic mark of temporary value was proved by the fact that the parent "mutant" lived for $2\frac{1}{2}$ years and that it suffered no apparent change, certainly no reduction of white, in its several plumages, while the "mutant" offspring of this bird replaced, when adult, their "mutational" first plumages with similar or identical or intensified "mutant" plumages. Furthermore, the last two "normal" birds of the season classified as "normal" in their first plumage showed advances toward the "mutant" condition in feathers developed later. This fact is described in detail in the section treating of the autopsies of this family. The mutational characters in question were, therefore, rather accentuated than diminished in the individual ontogenesis.

(5) Finally, though breeding tests were limited in this case to the data already given, such breeding tests have been quite thoroughly made in the case of at least two seemingly quite analogous cases: (a) The "Zenaida mutation," noted in Chapter X and fully described and illustrated in Volume I. This latter mutation has to do with the appearance of a white triangular mark in the feather-tips of the general plumage. Here, too, the original "mutant" arose in September—again the period of weakest germs. And (b) a second case, the "guinea-pigeon mutation," in which a loss of red, a *lightening* of the general color in the direction of the rock-pigeon, occurred, and which was likewise shown to be inherited in a fraction of the offspring. This latter "mutation" is also fully illustrated and described in Volume I (Chapter IX) of these works.

AUTOPSIES OF *T. ORIENTALIS* NO. 108 AND NO. 433 AND OF THEIR YOUNG, HATCHED IN 1912.

An answer to many questions which will arise in connection with the highly interesting family just described can be supplied only by the following information secured at the time of death of the various members of the family. The detailed statement concerning the "mutational" exhibitions of the several individuals concerned is also best given here.

Autopsy, 108♂.—Found dead March 8, 1913. On the previous day this bird did not seem sick, and at no previous time was it thought to be sick. Weight on February 18, 1913, showed, however, that the bird was considerably too light (218 grams). Was always a very quiet bird. Two small testes, two normal kidneys,³ and other viscera apparently normal, though feces somewhat greenish; a little food in crop. An evident collection of white mucus-like material at internal nostrils, but no canker found; brain apparently normal. Indeed, the examination failed to show why this bird

³ The last of the young (801) of the 1912 series was found December 13, 1912, to have but a single kidney. The parents and the other offspring which died later than did No. 801 were examined to see whether, by any chance, another instance of this unusual abnormality might be found in the same family.

should have died. Organs other than above noted seemed healthy. Wings, tail, and part of skin preserved; these whitened essentially as in all previous plumages. It was found that just proximal to the bronze edge of most feathers was to be found a very narrow black edge (this of course followed here also by white-to-gray) in many body and wing feathers.

Autopsy, 433 ♀.—Died November 27, 1913, on trip Chicago to New York; a nearly "naked" bird; was hardly expected to make trip successfully. Feathers present, mostly stunted and stubby. Two kidneys; no worms found; death apparently from weakness, exposure, and naked condition. Examined more than 24 hours after death.

AUTOPSIES OF YOUNG OF ABOVE PAIR IN ORDER OF HATCHING.

Autopsy, 895 ♀.—Died September 18, 1912. Nothing special noted other than the sex. Any change in color from its earlier state would certainly have been noted.

Autopsy, 885 ♂.—Died July 19, 1912. Dead in my absence and bird not fresh when examined. It had maintained its normal color or this would certainly have been remarked.

Autopsy, 826 ♂.—Died March 1, 1913. Emaciated; very small testes; two kidneys; left ureter distended with whitish semi-fluid (uric acid, etc.); right ureter empty. Color normal.

Autopsy, 818.—Disappeared (probably died) at 9 or 10 months. No white color had been noted in this bird. Sex unknown.

Autopsy, 891 ♀.—Died April 13, 1913. Ovary rather well developed; two kidneys; worms in greenish intestines; no tuberculosis.

The 6 old (full-grown) rectrices were normal color, but 6 short, newly growing (?) ones were all plainly grayed or whitened. 4 of the "mutant" feathers were on the right of center and 2 on left. (The 2 center feathers were "mutants".)

Right wing—Primaries: 1, normal color, long but worn; 2, normal color for half-length, then stunted and constricted at base, and showed a very narrow edge of white; 3, very small and short, apparently normal color; 4, still smaller, apparently normal color; 5, still smaller and apparently normal color; 6, small (size of 3), apparently normal color; 7, very small (size of 4), nearly pure white; 8, very small (size of 4), somewhat whitened; 9, very small and slender, somewhat whitened; 10, too rudimentary to study.

Secondaries: These normal color, but coverts of first 5 were all young, growing (?), and whitish. All old full-size secondary coverts were of normal color.

Left wing—Primaries: 1, old, broken off short; 2 to 6 (inclusive) very short (4 to 20 mm.); 7, inclosed in follicle, but whitened. 8, 9, 10 very short (10 to 16 mm.), of apparently normal color, except on extreme tip, where there was a very narrow edging of pure white.

Secondaries: Old long ones all normal color. Coverts nearly all normal; but the fourth, and possibly 1 or 2 more of the young and small ones, were whitened.

Autopsy, 879 ♂.—Died April 2, 1913. Testes exceedingly small, each less than half size of grain of wheat. Two kidneys. Probably digestive troubles; little or not at all emaciated. Except intestines, all organs seemed healthy. Primaries, secondaries, the primary coverts and body coverts normal or nearly normal. Possibly tertials were more gray than usual. Rectrices short and whitish or grayish-white, mixed with ashen-gray.

Autopsy, 880 ♀.—Died April 20, 1913. No trace of tuberculosis; intestines greenish, but no worms found; 1 and 3 days previous to death *santonine* given to expel worms suspected of being present.

Rectrices: 5 on left side, 6 on right; fourth from center here is short and nearly completely white.

Primaries: Of both wings all very short; longest = $1\frac{1}{4}$ inches. Bases of nearly, but not quite, all were constricted.

Secondaries: Four of these full length and normal color on left wing; others here small, 2 of them (first and second, or second and third) a bit whitened at tip. On right wing these latter feathers were smaller and very slightly whitened likewise. Here 5 secondaries were normal length and color; others small.

Tertiaries: One tertial of left wing was grayed on basal half.

Autopsy, 861 ♀.—Died at noon March 17, 1913. On this morning noted for first time that bird was not well. Slight intestinal (green) trouble, but hardly cause of death; this not revealed by autopsy. Crop and gizzard with food; liver, lungs, and heart apparently normal. Two kidneys; mouth and head normal. Only stubby rectrices and primaries. Rectrices white or very gray; bases of most but not of all these constricted and growth stopped.

Autopsy, 874 ♀.—Died April 9, 1913. A female with a fairly well developed ovary. Eggs about 1 mm. diameter; two kidneys. Rather greenish intestines, with worms. The intestine may have been *perforated* by one of two large worms ($1\frac{3}{4}$ inches long). No trace of tuberculosis.

Rectrices and coverts white or whitened when present, except for two middle rectrices which were normal (ends broken off). These perfect rectrices had no obvious constrictions at bases; practically all others did. These latter mostly short and obviously stunted. Not a single full-grown primary in either wing, and but one full-grown secondary (normal color it was) in the two wings. Most of the stunted secondaries and their coverts were gray or whitened at one or all parts, and 2 tertials were found to be obviously turned to gray in their unfolded portions not far above the terminal constrictions.

Autopsy, 859♂.—Died March 26, 1913. Two kidneys; left foot with toes curled and useless; testes small, not emaciated, but bird small; yellowish over peritoneum and pericardium; also diseased (yellowish) streak within wall of gizzard. Primaries, secondaries, and rectrices all, or nearly all, stubby, broken, contracted roots—many of these whitened.

Autopsy, 801.—Died December 13, 1912. Sex doubtful; undeveloped gonads, two in number. Only one kidney, with the normal site of the other perfectly clean, whitish bone, free of tissue! Feathers much stunted; color white to very gray. Always a weak bird; two "club" feet.

INBREEDING, FERTILITY, AND LONGEVITY IN THE OFFSPRING OF JAPANESE TURTLE-DOVES OF PAIRS 4 AND 5.

In view of the results of the breeding of "mutant" 108, as just given, it will now be well to present data upon the breeding and inbreeding of his brothers and sisters; also these data for his half brothers and sisters, and further the facts learned from crossing many of these individuals with other species—*St. risoria* and *St. alba*.

Brother-and-sister matings.—Five pairs of the earlier young of ♂ *T. orientalis* (2) × ♀ *T. orientalis* (2) were mated *inter se*. The results show that the germs of related doves do not attain the strength of the germs which produced the parents themselves. In only a single instance did any of the numerous eggs of these matings produce a young that lived as long as its shorter-lived parent. These matings—22 × 21, 22 × 14, 25 × 23, 40 × 60, 35 × 30—are treated fully in the accompanying tables, and briefly in the following paragraphs. The origin of all the birds concerned may be seen in table 19.

In the first of these matings of brother and sister, both parents being under maturity, the average life of (3) offspring is (for 22 × 21) 2½ months. For 14 × 21, when both parents were 1 year older, this average (for 4) is 9 months. The total production of eggs for pair 22 × 21 (table 21) during more than a year is only 8; and 50 per cent of these were unhatchable. The same female when a year older and with an older mate produced at least 8 eggs in less than a year and all of those tested (4) were hatched. The early death of the male of the 22 × 21 mating is a further pertinent fact in a consideration of the weakness of those germs.

When the birds of the next mating (25 × 23) were but little more than a year old they were able to hatch 2 young; at 2 years 4 of 6 eggs hatched, but the young were short-lived. In their third year the only 2 eggs known to have been laid were hatched; the young again were probably short-lived (table 22). The immature brothers and sisters, in mating 40 × 60 and 35 × 30 (table 22), gave progeny (3) with an average length of life of 3 months, with one striking exception (from 35 × 30), which lived about 60 months. It is notable that the male parent of this exception lived longer than any other bird of the group of parents now being considered (and at 10 years is still alive and partially fertile with an overworked *St. alba*). In 7 of the 8 pairs of eggs for which the data are adequate, the first egg of the clutch produced a stronger or longer-lived bird than did the second egg.

Reproductive overwork does not play a part in these several matings; immaturity and inbreeding are the obvious causes of the production of these several lots of extraordinarily short-lived offspring.

Crosses with Streptopelia.—Before undertaking a consideration of inbreeding in other than brother-and-sister matings it will be well to note the results of crossing members of the family under consideration with two species of a related genus. It will here become apparent that the earlier stronger, non-inbred young of pair 4 (σ° *T. orientalis*, 2 \times ♀ *T. orientalis*, 2) are highly fertile, and their offspring are long-lived. On the other hand, similar crosses of the brothers and sisters of the "mutant" No. 108 (from pair 5 = σ° 69 \times ♀ 2) were less fertile, and their offspring lived less long. These data have been condensed as much as possible, and the references to the tabulated data given under two headings soon to follow.

The records for female No. 99, covering a period of 4 years, are given in tables 23 and 24 and present the following situation: (1) This apparently normal bird, from one of a series of germs containing some obviously weak ones, was in reality also a weak bird, at least in respect to fertility. (2) Fertility, or developmental power, is weak between her and a species with which her species is normally quite fertile. (3) During her own lifetime this female presents a sliding scale of fertility. Highest fertility was reached in her second reproductive year (1912). In the third year, from 17 efforts only 2 were hatched, and 1 additional embryo (1 to 2 days?) formed. In her fourth year her eggs showed no trace of development. (4) In this fourth year many clutches of 1 egg only were laid.⁴

The results from the brother, No. 105, were still less favorable, as may be seen from the condensed statement given below and from table 25. This male was so little aggressive that he failed to win as mates 3 of the females long kept with him. In his fourth year, the last test, he was more fertile than formerly; but for 5 months following that period he remained idle while confined with his sister (99), whose record has just been given.

The condensed fertility records given below will facilitate a detailed comparison, by those particularly interested in the matter, of the relative fertility of the inbred and the non-inbred members of this family. The relative longevity which is associated with the different levels of fertility is also displayed by these records and by the tables to which these records refer.

CONDENSED FERTILITY RECORDS OF NON-INBRED OFFSPRING OF σ° *T. ORIENTALIS* 2 \times ♀ *T. ORIENTALIS* 2.

♀ 13. *T. orientalis*; 5/28/03; 3/4/06; 2 yr. 10 mo.

During the years 1904 and 1905 this bird proved mostly fertile with *St. risoria* (table 47), and the offspring were long-lived.

σ° 14. *T. orientalis*; 7/6/03; 6/3/09; 5 yr. 11 mo.

In 1904 tested fully fertile with *St. risoria*; the young were long-lived (table 48). Fertility with a sister (in 1907) was considerably lower, and the term of life of the offspring was much shorter (table 21).

⁴ It may be further noted that investigation (by O. R.) of the egg-yolks of this bird has furnished two interesting facts: (a) the yolks are all abnormally small for this species; (b) the normal size relations between first and second egg do not obtain. Whereas, in this species, the yolk of the first egg in a large percentage of cases is smaller than the second, the 11 pairs of eggs for which we have perfect weighings show 5 clutches with the first egg larger, 5 in which the second is larger, and one in which they are equal. Note that the breeding data of 1912 correspondingly show less developmental energy in the first egg of two clutches (H, J), and more in the first of two other clutches (D, E). In one other (G) it is different, but the order of the eggs is unknown. And similarly, this bird, contrary to the normal for the species, is as likely to throw a female from the first egg (C, D, E) as from the second (H, J).

♂ 35. *T. orientalis*; 8/13/04; 10/1/14; 10+ yr.

This bird has a long and important history of matings with *St. alba*. This is given in tables 37 to 41. He has been tested with five different females. With the first four he was fully fertile and the offspring were long-lived. With the fifth—when the male was 10 years old and the female previously overworked—two clutches (4 eggs) only were produced in 4 months; one egg was entirely infertile; a second produced a weak crippled (right leg straight and horizontal) young that lived for 2 months and showed on autopsy no gonad whatsoever!

♂ 40. *T. orientalis*; 4/28/05; 5/1/13; 8 yr.

The mating of this bird with a sister (No. 60) in 1907 is given in table 22. These birds were then infertile. The record 1908–10, inclusive, is not known. During 1911 this male kept with a female *alba* × *orientalis* hybrid (12) without mating. Continued 1912 until Sept. 3 without result. When offered *T. orientalis* No. 88 she was accepted at once and a few fertile eggs produced, as indicated in detail elsewhere (table 26a).

♂ 66. *T. orientalis*; 6/6/06; alive 7/2/07; 1+ yr.

Tests made only with the usually infertile, or little fertile, *risoria* × *orientalis* hyb. (2). The pair proved partially fertile in 1907 (table 51).

♂ 69. *T. orientalis*; 7/17/06; alive 9/1/14; 8+ yr.

During 1909 and 1910 this male mated with his mother and produced whitened "mutant" offspring as shown in table 19. Until October 17, 1911, this bird was with a female *St. alba*, with which it probably mated and produced a few eggs, the fertility of which is not known. After the above date put with a female *orientalis* × *alba* hybrid (27); no eggs during the autumn. These birds produced during 1912, 64 eggs; 39 of these were tested for fertility and all proved absolutely infertile; these hybrids and their reciprocals are usually quite infertile. Before May 16, 1913, 23 eggs were produced; none tested for fertility. From May 16 to September 30 No. 69 was with female *T. orientalis* No. 433 (hardly sufficient feathers to fly) without mating. From September 30, 1913, to 1914 this male was with a female *T. orientalis* (429), whose record is given in table 30. These two related birds gave poor results.

♂ 76. *T. orientalis*; 3/17/07; stolen 8/12/12; 5+ yr.

In 1909 this bird was fully fertile (3 eggs) with an *orientalis* (38) of uncertain ancestry; in 1910, when mated to his immature niece (88), he was probably fully fertile (table 26), but the young were short-lived. During 1911 this more mature mating was fully fertile (26 young), and the offspring lived longer (table 27) than did those from the previous matings. It is upon this family (of 1911) that chapter 6 is based. From about March 1912 this male was without opportunity to mate until June 12; then with female *St. alba* (459) without mating; stolen August 12, 1912.

CONDENSED FERTILITY RECORD OF INBRED OFFSPRING OF FEMALE *T. ORIENTALIS* NO. 2, WHEN OLD AND MATED TO A SON, NO. 69.

♀ 99. *T. orientalis*; 6/4/10; alive 10/1/14; 4+ yr.

Mated with her brother (105), this female produced 2 eggs about May 20, 1911. July 2, 1911, she was given female *alba* × *orientalis* hyb. (27), with whom a mating possibly occurred; but No. 99 probably laid no eggs. On September 17 she was put in a cage with 2 unmated birds—male *St. alba* (226) and female *T. orientalis* (2); no result. On April 24, 1912, put with a male *St. alba* (462) and was then fully fertile, as is shown in table 23; later she largely lost fertility, as shown in table 24. Kept October 24, 1914, to March 20, 1915, with a brother (No. 105) without results.

♂ 105. *T. orientalis*; 7/25/10; alive 10/1/14; 4+ yr.

In 1911 this male till July 2 with his sister (99). A clutch was produced by the pair; these crushed, probably fertile. After July 2 with female *alba* × *orientalis* hyb. (27); failed to mate. May 30 to September 3, 1912, with a *St. alba* (died October 9, 1912) without result. September 3 to October 11 with female *St. alba* (492) (dead December 9, 1912) without result; after October 11, 1912, with male *T. orientalis* (446). During 1913 (after April 30) and 1914 mated with female *St. alba* (517); this pair in 1913 produced infertile eggs (female was rather young); in 1914, many infertile and some fully fertile eggs, as shown in table 25. Kept October 24, 1914, to March 20, 1915, with sister (99) without result.

♂ 108. *T. orientalis* ("mutant"); 9/7/10; 3/18/13; 2 yr. 6 mo.

This male put May 23, 1911 with a one year old male *T. orientalis* (101). The sex of neither was known; they remained together without mating behavior; but the "mutant" was twice recorded as "in the nest." From August 3 to October 13 male *St. alba* (26) was given. On March 22, 1912; this male was given female *T. orientalis* 433, which had laid one or two clutches of eggs; a mating was effected at once. The interesting result of this mating is given in table 20. These birds were kept together during the winter of 1912–13 without eggs; though the failure was probably the fault of the female, which was insufficiently provided with feathers, particularly flight feathers. The male, always a very quiet bird, was thought, till found dead, to be healthy (though too light = 218 g. instead of 240 to 250 on February 18, 1913). The autopsy failed to reveal the cause of death; the testes were remarkably small.

♀ 109. *T. orientalis*; 9/9/10; 9/3/12; 2 yr.

On July 2, 1911 a female *alba* × *orientalis* hyb. (10) was given; this latter female laid a clutch of eggs, and developed (in ovary) another clutch before removal on August 4, but ♀ 109 laid no eggs and showed no signs of mating. On August 4 a male *St. alba* (228) was given with no result. From early 1912 to June 2 with male *St. alba* (459) with no result. From June 2 till dead on September 3 with a female *St. alba* (492). The latter bird (dead December 9, 1912) laid 10 eggs during this time—all, of course, infertile; ♀ 109 laid none. It was not thought, till autopsy, that this bird was a female. In view of the above record of two different females having laid eggs when confined with this bird, it seems not improbable that an actual mating occurred in each instance; but this weak female was perhaps "unable to produce eggs" under this degree or kind of stimulus; perhaps this history raises a question as to her power to produce eggs at all.

INBREEDING OF UNCLE TO NIECE AND ORIGIN OF AN INTERESTING FAMILY OF INBREDS.

Besides the male "mutant" No. 108, whose mating with a relative has been described at length, 3 of the offspring of his mother, *T. orientalis* 2, were inbred, but in other than brother-and-sister matings, and founded stock not strong, although strong enough to reproduce, and thus permit a further study of the effects on the germs of continued inbreeding in these doves. In general the matings given here are of uncle and niece. One such pair yielded a large family of inbreds which become the center of interest in the next chapter. The data for this degree of inbreeding is presented in three tables given herewith. These data strongly reinforce those derived from the brother-and-sister matings, and from inbred birds out-crossed to other species, in that they indicate that *these immature and inbred doves may produce offspring; but not offspring that will live the normal span of life.* The following statement sufficiently analyzes the individual matings:

The shortest and least instructive mating of the series concerns a male (40) which, when not fully mature, tested at least partially fertile with a sister (table 22). With a niece (88) this male was given two further tests of fertility (table 26A); these two eggs hatched, but the young from the second egg of the clutch (laid last of September) lived but 3 days. The other bird was a female that lived for 6 months.

The individual tabular records for male No. 76, during 3 years of matings, bring out the following facts: When the male was little more than 2 years old, and mated with a female of unknown ancestry though probably related and probably 3 or 4 years old, the progeny (3) averaged probably 9 to 10 months (table 26). But when 3 years old, mated to an immature (2 years old) daughter of his sister (88), only one of 7 young lived as long as 9 months. This one, however, from a strong germ of the latter part of May, escaped at 25 months. 4 of the 7 young died at the age of 5 to 9 months, and the last 2 of the season at only 1 month (table 26). During the following year (1911), when the male was a little more than 4 years old and his consort was reaching maturity (3 years), the progeny (about 25) lived 24+ months (3 still alive). This particular family, whose detailed history is given in table 27, it will be noted, is a large one and was produced under overwork; the term of life of the offspring was, however, sufficiently long to permit breeding tests with many of them. The results of the further special study of this family will be given in the following chapter.

The last pair of eggs for the seasons 1910 and 1911 produced birds with the *shortest* life-term; and the *longest* life-terms are grouped toward the earlier part of the season. Birds from the first egg of 3 clutches lived longer than birds from the second; less long in 1 or (?) 2 cases.

The sex data for the progeny of this male and his two consorts are in many respects meager and incomplete; combined with the data for longevity, they may be compactly given as follows:

1909, the (?) related nearly mature mate gave.....	2♂; 0♀; 1? ($9\frac{1}{2}$ months).
1910, the inbred, immature mate gave.....	1♂; 2♀; 5? (8 months).
1911, the inbred, less immature mate gave.....	7♂; 9♀; 9? (24+ months).

When, therefore, the parents were more mature, the progeny lived longer; probably there was then, too, a higher proportion of males.

A similar summary statement for the second of the two females (88) used in the above matings is of interest. It will be noted that female No. 88, herself the

strongest of a weak progeny (table 18A), produced inbred offspring from 2 different males (uncles) during 3 years—her second, third, and fourth years. The number of eggs, offspring, and the data for sex and longevity from these three years (tables 26, 27, 26A) is as follows:

1910 (σ^3 76), 10 eggs, 10 tested, 8 hatched, 1 ♂, 2 ♀, 5? (78 months).
1911 (σ^3 76), 30 eggs, 25 tested, 25 hatched, 7 ♂, 9 ♀, 9? (26+ months).
1912 (σ^3 40), 10 eggs, 2 tested, 2 hatched, 0 ♂, 1 ♀, 1? (3½ months).

It is obvious, therefore, that, in the inbreeding of uncle and niece, among Japanese turtle-doves, a long-lived progeny is difficult to obtain. The results are, however, more favorable than were obtained in the brother-and-sister matings. They are at the same time less favorable than the out-crosses with *Streptopelia*. These several matings all disclose the weakness of the last germs of the season.

The large family produced in the uncle-and-niece mating of 1911, whose origin in detail is given in table 27, becomes, in the next chapter, the subject of a further study on the relation of "season of hatching" to "fertility."

TABLE 20.

σ^3 108 "Mutant" <i>T. orientalis</i> ; "much white" 9/7/10.....	3/8/13; 30 mo. 1 da. (see pl. 7).
♀ 433 Normal (?) <i>T. orientalis</i> , 7/18/11.....	11/27/13; 28 mo. 9 da. (see pl. 7).

The parents are both inbreds, and are related (see sketch of this, page 42).

AA 1. 3/19/12; ? deserted.				
AA 2. 3/21/12; ? deserted.				
A 1. 4/1; no development.	C 1. 4/28; no development.			
A 2. 4/3; no development.	C 2. 4/30; no development.			
B 1. 4/19; not tested.	D 1. 5/8; trace development.			
B 2. 4/21; soft shell.	D 2. 5/10; 4 to 5 day embryo.			
♀ E 1. 5/30.....	normal.....	895.....	dead 9/18/12.....	3 mo. 18 da.
♂ E 2. 6/1.....	normal.....	885.....	dead 7/19/12.....	1 mo. 18 da.
F 1. 6/8; not tested (analysis).				
F 2. 6/10; not tested (analysis).				
♂ G 1. 6/18.....	normal.....	826.....	dead 3/1/13.....	8 mo. 12 da. (see pl. 7)
G 2. 6/20; trace, or no development.				
H 1. 6/27.....	normal.....	818.....	disappeared (probably dead) at 9 or 10 mo.	
H 2. 6/29; failed to hatch.				
I 1. 7/6; 13 day embryo (irregular incubation).				
♀ I 2. 7/8.....	normal.....	891.....	dead 4/13/13.....	9 mo. 5 da. (see pl. 7)
♂ J 1. 7/14.....	white tail.....	879.....	dead 4/2/13.....	8 mo. 19 da. (see pl. 7)
♀ J 2. 7/16.....	normal.....	880.....	dead 4/20/13.....	9 mo. 4 da. (see pl. 7)
K 1. 7/24; on ground, broken.				
K 2. 7/26.....	hatched S/10.....		dead 8/12/12.....	17 da.
♀ L 1. 8/1/one white tail +.....		861.....	dead 3/17/13.....	7 mo. 17 da. (see pl. 7)
♀ L 2. 8/3/other white tail +.....		874.....	dead 4/9/13.....	8 mo. 6 da. (see pl. 7)
♂ M 1. 8/12/one much white ¹		859 ^c	dead 3/26/13.....	7 mo. 14 da. (see pl. 7)
M 2. 8/14/other much white ²		801 (?).....	dead 12/13/12.....	4 mo. (see pl. 7)

In 1913 this female refused to mate with male *T. orientalis* (69). She died from exposure (was nearly naked) on trip—Chicago to New York—more than 15 months after the close of the above record. From 9/30 to 11/26/13 she was with a *St. alba* (σ^3 672) without mating (could not gain perch). (O. R.)

¹ Also club feet, defective feathering.

² Also club feet, defective feathering, and only one kidney.

TABLE 21.

σ^3 <i>T. orientalis</i> (22); 9/20/03; brother; 6. 19/06; (one blind eye); 33 mo.	
♀ <i>T. orientalis</i> (21); 9/18/03; sister; 7. 12/08; (has bad eye); 58+ mo.	

A 1. 4/1/05; some development.

A 2. 4/3/05; some development.

B 1. 6/27.....	50.....	dead.....	8/26/05.....	2 mo.
B 2. 6/29; pricked shell, unable to hatch.				

TABLE 21 (*continued*)

C 1. 4/1/06.	63	dead	7/12/06	.3 mo. 11 da.
C 2. 4/3/06; unhatched.				
D 1. 5/4.	64	dead	7/28/06	.2 mo. 24 da.
D 2. 5/6.	65	dead		
♂ 22 died 6/19/06.				
In 1907 used ♂ <i>T. orientalis</i> 14, brother of ♀ 21; 7/6/03-6/3/09; 70 mo. 27 da.				
? 1. ?/07; deserted.			? 1. ?/07; deserted.	
? 2. ?/07; deserted.			? 2. ?/07; deserted.	
A 1. 4/6.	80	dead (blind eye)	12/5/07	.8 mo.
A 2. 4/8.		dead (blind eye)	5/18/07	1 mo. 10 da.
B 1. 5/16.	83	dead	7/6/09	25 mo. 20 da.
B 2. 5/18.		dead	6/8/07	.20 da.

March to May several sets of eggs; *none hatched* till:

C 1, 5/26/08, 87; death not recorded.

C 2. 5/28/08; unhatched.

Female parent killed 7/12/08, with a bad eye.

(F 28)

TABLE 22.

♂ *T. orientalis* (25); 4/10/04; brother; no record of death.
 ♀ *T. orientalis* (23); 3/7/04; sister; no record of death.
 E 1. 4/3/06; 62; hatched, probably short-lived.
 E 2. 4/5/06; 63; hatched, probably short-lived.
 F 1. Not hatched.
 F 2. Not hatched.
 ♂ G 1. 9/12...72...dead...12/31/06.....3 mo. 19 da.
 G 2. 9/14...73...dead..."winter 1907"....4? mo.
 H 1. 6/4/07; hatched, probably short-lived.
 H 2. 6/6/07; hatched, probably short-lived.

♂ T. orientalis (35); 8/13/04; brother; alive 6/1/14; 118± mo

♂ T. orientalis (30); 8/13/04; brother; alive 8/1/11; 11

♀ A 1. 7/6/05.....53.....dead.....10/3/05.....2 mo. 27 da.
 A 2. 7/8/05; prickled shell, failed to hatch.

♂B1, 8/17.....55.....dead.....12 20/05.....4 mo. 3 da.
 ♀B2, 8/19.....54.....dead.....11/?/09-12/?/10(?).....60 mo.

♀ 30 mated 1906 with a ♂ white ring-dove.

♂ 35 mated 1906–14 with ♀ white rings 67, 87, 8, 649, 772; (see tables 37 to 41).

♂ *T. orientalis* (40); 4/28/05; brother; 5/1/13; 96 mo. 3 da.

♂ T. orientalis (40); 4/28/05; brother.

♀ A 1. 7/8/07.....\$4.....dead.....10/20/07.....3 mo. 12 da.
 A 2. 7/10/07: no record; almost certainly not hatched. (F 28)

TABLE 23.

♂ St. alba (462); (♀ alba-♀ risoria); May 1911; 10/31/14; 41 mo.
♀ T. orientalis (99); 6/4/10; alive; 4; 1/15; 60+ mo.
♂ B 1. 6/18/12..... dark..... 856..... alive 4/1/15..... 33+ mo.
♂ B 2. 6/20/12..... dark..... 836..... alive 4/1/15..... 33+ mo.
♀ C 1. 6/28..... white..... 866..... escaped 6/1/13.
♂ C 2. 6/30..... dark..... 841..... escaped or disappeared about 1/1/14.
♀ D 1. 7/9..... white..... 835..... stolen 7/4/13.
D 2. 7/11; little development.
♀ E 1. 7/20..... white..... 815..... alive 4/1/15.
E 2. 7/22; 6 to 7 day embryo.
♀ G 1. 8/6..... white..... {one?..... dead 8/23/12..... 2 da.
♀ G 2. 8/8..... white..... [855]..... alive 4/1/15..... 32+ mo.
H 1. 8/13; no development.
♀ H 2. 8/15..... white..... 897..... killed 9/18/12.
♂ I 1. 8/23..... dark..... 820..... alive 4/1/15..... 31+ mo.
♂ I 2. 8/25..... dark..... 860..... alive 4/1/15..... 31+ mo.
J 1. 9/2; no development.
♀ J 2. 9/4..... white..... 896..... alive 4/1/15..... 31+ mo. (O. R.)

TABLE 24.

1913: ♂ St. alba (462) (con.).	1914: ♂ St. alba (462) (con.).
♀ T. orientalis (99).	♀ T. orientalis (99).
A 1. 1/30; analyzed.	A 1. 4/12; no development.
A 2. 2/1; analyzed.	A 2. 4/14; broken.
B 1. 2/9; analyzed.	B 1. 4/27; no development (analysis).
B 2. 2/11; analyzed.	B 2. 4. 29; analyzed.
C. 2/19; weighed yolk.	C. 5/6; no development.
D. 2/25; broken.	D. 5/11; no development (cold?).
E 1. 3/5; no development.	E. 5/19; no development.
E 2. 3/7; no development.	F 1. 6/8; no development.
F 1. 3/16; no development.	F 2. 6/10; broken.
F 2. 3/18; soft shell.	G. 6/17; calorimeter.
G 1. 3/27; weak shell.	H. 6/23; calorimeter.
G 2. 3/29; no shell.	I. 7/5; no development.
H. 4/11; no development.	J. 7/9; soft shell (calorim.)
I. 4/21; broken.	K 1. 8/6; analyzed.
J 1. 4/30; analyzed.	K 2. 8/8; analyzed (thin shell).
J 2. 5/2; analyzed.	L. 8/15; analyzed.
K 1. 5/9; analyzed.	M 1. 8/29; no development.
K 2. 5/11; analyzed.	M 2. 8/31; no development.
L 1. 5/16; no development.	N 1. 9/11; no development.
?♂L 2. 5/18; injured hatching; dark.	N 2. 9/13; 5 day embryo.
M 1. 5/23; no development.	Bird injured herself in flight soon after above eggs
M 2. 5/25; no development.	were laid; no more eggs during 1914.
N 1. 5/31; analyzed.	
N 2. 6/2; analyzed.	
O 1. 6/9; no development.	
O 2. 6/11; no development.	
(Nested eggs here to give a rest).	
P 1. 7/11; no development.	
P 2. 7/13; 1 to 2 day development.	
Q 1. 7/22; no development.	
?♂Q 2. 7/24; 760; dark; alive 8/1/14.	
R 1. 8/3; no development.	
R 2. 8/5; no development.	
S. 8/15; no development. ¹	(O. R.)

¹ The female noted 9/12/13 to have a scurvy, scaly-like affection on legs and ear.

TABLE 25.

♂ T. orientalis (105); 7/25/10; dead 3/28/15; 4 yr. 8 mo.	
♀ St. alba (817) (trace of risoria); 11/30/12; alive 10/9/14; 22 ¹ mo. ¹	
(For the earlier—mostly unsuccessful—attempts at mating 105 see under “condensed records,” already given.)	
A 1. 4/28/13 (first egg in life); analysis.	E 1. 7/30; broken 8/2=a 1 to 2 day embryo.
A 2. 4/30/13; analysis.	E 2. 8/1; broken 8/2.
B 1. 5/31; analysis.	F 1. 8/8; no development.
B 2. 6/2; analysis.	F 2. 8/10; no development.
C 1. 6/13; no development.	G 1. 9/10; no development.
C 2. 6/15; no development.	G 2. 9/12; no development.
D. 6/21; soft shell.	H. 9/22; no development.
(Insistent nesting here.)	I 1. 10/13; no development.
	I 2. 10/15; no development.

¹ On 7/1/14 the dam (817) was recorded as tubercular; dead 10/9/14; showing tubercular lungs, liver, spleen, and joints. But since the eggs of April and May of the second year produced young, this female (mature at 5 to 6 mo.) can hardly be held responsible for the earlier infertility.

TABLE 25 (*continued*).

A 1. 1/21/14.	B 1. 2 21; analysis.	H 1. 4/21; analysis.
A 2. 1/23/14.	B 2. 2 23; analysis.	H 2. 4/23; analysis.
C 1. 3/10; no development.		♂ I 1. 4/29; 525; alive 4/1/15.
C 2. 3/12; no development.		♂ I 2. 5/1; 534; alive 4/1/15.
D 1. 3/18; no development.		J 1. 5/13; 4 to 5 day embryo.
D 2. 3/20; no development.		♀ J 2. 5/15; 596; alive 4/1/15.
E 1. 3/27; no development.		K 1. 5/21; no development.
E 2. 3/29; no development.		K 2. 5/23; no development.
F 1. 4/4; no development.		L 1. 6/1; dwarf egg; trace of yolk.
F 2. 4/6; no development.		L 2. 6/3; remainder of above yolk (infertile).
♂G 1. 4/13; dead (cold); 5/5.14.		M. 6/12; no development. ²
G 2. 4/15; no development.		(O. R.)

² Male 105 with sister (99) from 10/24/14 to 3/20/15, no result.

TABLE 26.

♂ T. orientalis (76); 3/17/07; stolen 8/12/12; 65+ mo.	
♀ T. orientalis (38); (? 1905 or 1906?); (ancestry doubtful, but probably related to ♂ 76) ? mo.	
A. 4/30/09.....92.....dead; (certainly before 12/20/10).	
♂B 1. 7/12.....93.....dead.....11/24/10.....16 mo. 12 da.	
♂B 2. 7/14.....94.....dead.....10 19 09.....3 mo. 5 da.	

♂ T. orientalis (76) as above; uncle; 65+ mo.

♀ T. orientalis (88); 6/23/08-4/23/13; niece; 58 mo.

Mother of SS=a sister (11) to 76.

♂A 1. 5/26/10.....101.....escaped.....6/23/12.....	25+ mo.
♂A 2. 5/28/10.....102.....dead; not well fed.	
B 1. 7/13; no record.	
B 2. 7/15; 3 to 5 day development; probably deserted.	
C 1. 7/19.....102.....dead between 2/17/11-4/30/11.....	8 to 9 mo.
♀C 2. 7/21.....103.....dead.....1/15/11.....	5 mo. 24 da.
♂D 1. 8/22.....106 ¹.....dead.....2/10/11.....	5 mo. 17 da.
♀D 2. 8/24.....107.....dead.....2/25/11.....	6 mo. 1 da.
E 1. 10/13.....110.....dead (cold?).....11/12/10.....	1 mo.
E 2. 10/15.....111.....dead.....11/12/10.....	1 mo.

Breeding continued 1911 by O. R.

(F 28)

¹ Autopsy showed only one questionable gonad; large wolffian body, and abnormal kidney.

TABLE 26A.

♂ T. orientalis (40); 4/28-05; uncle; 5/1/13; 72 mo.	
♀ T. orientalis (88); 6/23/08; niece; 4/23/13; 58 mo.	
F 1. 9/17/12; not tested.	
F 2. 9/19/12; not tested.	
♀G 1. 9/28.....840.....dead.....4 5 13.....	6 mo. 7 da.
G 2. 9/30.....dead.....10 18 12.....	18 da.

These birds together until death of SS on 4/23/13, but produced no eggs.

(O. R.)

¹ This male was from ♂ 2 × ♀ 2, and thus a brother to the father of ♀ SS.—EDITOR.

TABLE 27.

♂ T. orientalis (76); 3/17/07; stolen 8/12/12; uncle; 65+ mo.	
♀ T. orientalis (88); 6/23/08; 4/23/13; niece; 58 mo.	
♂A 1. 5/15/11 | one \ 452.....dead 5/16/13.....	24 mo.
♂A 2. 5/17/11 | one \ 446.....dead 2/21/13.....	21 mo. 5 da.
B 1. 5/29; healthy young killed by foster parents.	
B 2. 5/31; healthy young killed by foster parents.	
♂ C 1. 6/10 } one \ 412 ♂.....dead 3/25/13.....	21 mo. 14 da.
♂ C 2. 6/12 } one \ 500 ♀alive 1/15.....	43+ mo.
♂ D 1. 6/24 } one \ ... ♂dead 7/14/11.....	20 da.
♂ D 2. 6/26 } one \ 481 ♀alive 1/15.....	43+ mo.

TABLE 27 (*continued*).

E 1. 7/3.....	starved.....	dead 7/29/11.....	24 da.
E 2. 7/5.....	starved.....	dead 7/29/11.....	24 da.
♀ F 1. 7/17 } one { 433.....		dead 11/27/13.....	28 mo. 9 da.
♀ F 2. 7/19 } one { 489.....		dead 3/28/13.....	20 mo. 10 da.
? ♂ and ? ♂ G 1. 7/25 } one { 440? ♂.....		escaped ¹ between 10/24-12-12, I 12.....	16+ mo.
? ♂ and ? ♂ G 2. 7/27 } one { 442? ♂.....		disappeared 5/1/12.....	10+ mo.
H 1. 8/6.....	428; escaped before 12/1/12.		
♀ H 2. 8/8.....	429.....	alive 1/1/15.....	41+ mo.
♂ I 1. 8/14.....	464.....	alive 1/1/15.....	40½+ mo.
I 2. 8/16.....	444; disappeared before 12/1/12.		
♀ J 1. 8/22.....	454.....	dead 3/24/13.....	19 mo. 2 da.
J 2. 8/24; (yolkless egg).			
♀ K 1. 9/1.....	475.....	dead 3/23/13.....	18 mo. 22 da.
K 2. 9/3; drowned at two weeks.			
♂ L 1. 9/14 } one { 421.....		dead ² 1/1/15.....	39½ mo.
♂ L 2. 9/16 } one { 488.....		dead 4/23/13.....	19 mo. 7 da.
♀ M 1. 9/26.....	436.....	dead 4/5/13.....	18 mo. 9 da.
♀ M 2. 9/28.....	423.....	dead 2/21/13.....	16 mo. 23 da.
N 1. 10/21; not incubated.		O 1. 11/6; not incubated. ³	
N 2. 10/23; not incubated.		O 2. 11/8; not incubated.	(O. R.)

¹ Copulated as ♂; laid no eggs; eggs of *alba* consort absolutely infertile.² The sex-glands certainly abnormal, *no right testis* discernible. The left testis exceedingly small (less than 4 mg.) when bird died of tuberculosis.³ ♂ 76 and ♀ 88 were left together until 4/15/12. Four clutches of 1 egg each were laid 1/6 to 3/10; all on floor and fertility not determined; 4/14-16 another clutch. *St. alba* ♂ 224 was then offered, but not accepted. On 9/3 *T. orientalis*, ♂ 40 was given. They then produced only two clutches as shown in table 26A.

CHAPTER VI.

EFFECT OF SEASON OF HATCHING UPON DISTRIBUTION OF FERTILITY AMONG THE OFFSPRING OF AN OVERWORKED PAIR OF JAPANESE TURTLE-DOVES.¹

In earlier chapters the function of fertility has been examined in its relation to sex and to longevity, and with reference to its dependence upon age, seasons, inbreeding, width of cross, and the experimentally induced "overwork." Some later chapters, too, bear in part upon those topics. It is now, however, of interest to inquire whether the reduced fertility or "weakness" of germs is continued into the germs of the next generation, *i.e.*, whether this reduction is of significance in heredity as well as in the individual development. The demonstration of the relation which fertility bears to the development of sex is sufficient definitely to give it a genetic value, but we may now examine more specifically some data that have to do with the question of the continuance in the offspring of the lower and higher levels of fertility which have been seen to correspond to *season*.

In the preceding chapter the continuance of low levels ("mutations") of certain characteristics, which were likewise originally induced by extreme age and inbreeding, have been considered. Near the conclusion of that presentation the inbred family (table 27) which now becomes the subject for special treatment was referred to briefly.

The relationship of the two birds chosen as parents for the family in question, and the earlier performance of these same birds (table 26A) was, for us, a sufficient guarantee that some weak progeny could be secured from this mating at the extreme end of the season; and if a considerable amount of "overwork" could be induced, sufficiently large numbers of young might be secured in a single season to supply material for an additional test—a further comparative test—to learn whether the germs of birds which themselves arose from germs of reduced fertility will in turn reveal reduced fertility;² and whether birds from the same parents, proceeding from stronger, more fertile germs, will in turn form germs of higher developmental power.

The investigation of the fertility of the young of this pair of birds bred in 1911 has supplied a body of very interesting data. It is perhaps still too early to write the complete story of their relative fertility, since some of the family are still alive. It is nevertheless already clear that those birds which developed from the "stronger germs" of the earlier part of the season of 1911 in their turn have produced germs of greater developmental power than have been produced by their brothers and sisters hatched from eggs laid later in the season under stress of reproductive overwork.

¹This chapter was written wholly by the editor, and is based upon a breeding study which was also carried out by him (see next foot-note). The study is based on a mating (Table 26) arranged and followed during 1910 by the author.

²An early examination of the author's manuscripts by the editor made it clear that although there was much evidence bearing on this point (of a continuance of reduced fertility from an induced low fertility and an association of weak germs with femaleness), the form of the records would make it difficult or impossible for any one other than the author to present the "whole" of the fertility tests for all of the members of any large family treated in the author's records. It was therefore decided to make of this series of 1911—the series now about to be described—a new and additional test of the matter. By making the records himself, and having this specific point in mind in making the matings for the fertility tests, the editor is able to give a fairly full account of this test case.

In this series, from a single season, there are 19 birds which lived long enough normally to seek expression of their sexuality. They arose from a series of 30 eggs (table 27). They are the result of inbreeding together with "overwork," and (for some of them) late season. All of these factors are seen elsewhere, as well as here, to produce weakened germs. *In this case, moreover, it would seem (1) that developmental power was bestowed upon this family sufficient to produce fully fertile females, but insufficient to produce fully fertile males; (2) that only those females that arose from the stronger earlier germs were possessed of high, full, or complete reproductive power.* In other words, females only in this family exhibit the function of fertility unreduced; and only those particular females which were obtained from the stronger earlier eggs of an overworked female parent exhibit an unreduced or but slightly reduced fertility; their sisters from the weaker germs of late in the season show less fertility or no fertility. This differential of fertility for the sexes was an unexpected though probably a significant result.

Perhaps if this situation were stated in terms of Professor Whitman's views on fertility, season, and of the relation the sexes bear to each other it would be simply this: The mating of related birds results in weakened offspring; the function of fertility suffers with other functions—it too is weakened; the effects of overwork and of lateness of season progressively accentuate this weakness. It would seem from the data of this chapter, that where fertility is much reduced *from these sources*,³ fully equipped females though not complete males⁴ may be produced; and that this may possibly have a bearing on the author's thesis that "the male goes (and must go) further in development than does the female"; or, again (if the present data were sufficient for a generalization), where developmental energy, from such a reason, is not of normal strength, females may be produced without obvious defect, but males then produced may bear obvious defect.

It may seem to some that there is here a contradiction of certain aspects of the principle of "reduced fertility in proportion to width of cross" which has been established in earlier chapters; for it was there found that the crosses of most widely separated species yield only or almost exclusively males, and that fertility is usually reduced in proportion to the width of crosses. In those cases too the individuals with rudimentary sex-glands were the occasional *females*, not the males.⁵ All is made clear, however, when one distinguishes, as has been done in Chapter III, between the two very different means of reducing the "fertility" of germs. In obtaining males from the "wide crosses," the "strongest" germs of the birds are utilized; and apparently there is here, as in the crossing of varieties, additional "strength" obtained by the mere act of crossing. The reduction of fertility which pertains to such wide crosses rests upon some "incompatibility," or lack of coöordination, of the two fused plasms, while the reduced "fertility" which is patent in the data now under consideration rests certainly upon a very different basis—upon "weakness" in fact. Here parents begin by supplying germs at once "weakened" by a union with a related (inbred) germ; in addition, too rapid work at

³ That is, inbreeding and lateness of season associated with overwork.

⁴ Recent quantitative studies on sex in pigeons by the editor go very far toward establishing the proposition that males are not only less likely to be produced, under the extreme conditions referred to here, but those which do arise are less "masculine" than are other males.

⁵ Note that in the family under consideration, 1 male, from the end of the season had only a single testicle.

egg-production further "weakens" the germs; and late season brings, in some way, a still further "weakness." It is from this sort of "reduced fertility"—a fertility founded upon weakness—that females have been obtained which are more adequate, more complete (in respect to fertility) than their brothers. Such weakness of developmental energy may produce, according to these data, a relatively perfect individual of the "weaker sex," but not a perfect individual of the sex which must go "further in development than the female."⁶

It is largely because of the obvious bearing which these data have upon Whitman's conception of the relation which the sexes bear to fertility, that advantage was taken of this large family to make a thorough study of the fertility of its members. Some of the same sort of thing may be found in many of the families bred by Professor Whitman himself, and he was plainly convinced that the weak fertility of a germ tends to be reproduced as weak fertility, and as weakness of other sorts, into the germs of the next generation. But an early examination of his data, together with some indications and references to this pair (which he had mated in 1910; see table 26), convinced the editor that the parents of this particular family should be left mated, the greatest possible number of offspring secured, and the fertility of these adequately studied. This chapter is, then, the result of such an effort.

Three means are used in the presentation of the results: (1) a very general textual statement; (2) a condensed table, followed by the more important individual tables which give a better and more detailed idea of the situation; (3) a very short and inclusive history (in smaller type) of the essential facts which a critical survey of the evidence would require. It will be noted that an attempt has been made to test the fertility of these young with each other and with another species (*St. alba*) with which *T. orientalis* is normally quite fertile.

An examination of the condensed tabulation (table 28) shows that all of the 7 males were deficient *as males*; 3 had opportunity to mate (after sexual maturity, of course) and failed; 3 others mated, copulated with egg-laying females, normally fully fertile with this species, and proved in all of many tests absolutely infertile. One male (421) which arose late in the season, but from a clutch of eggs which threw 2 males, was very weakly fertile. When a little less than a year old (with *St. alba*) this male proved practically infertile; 4 eggs were produced; 2 showed no trace of development, the other 2 gave rise to 2-day and 4-day embryos. During a second year half of the eggs tested with another *alba* were hatched, though half of the young died very early (see table 31). In his third year, with still another *St. alba*, this male is responsible for 20 absolutely infertile eggs and no fertile ones.

On the other hand, 2 females, the *first* and *third*, proved to be highly fertile, the first (500), with two different *St. alba* males, the third (433) with an inbred "mutant" *T. orientalis*⁷ (108). The second female (481) of the season has not yet been properly tested as to fertility, largely because of her low and peculiar fecundity and her abnormal eggs and egg-laying instincts. It turns out that the 4 of her eggs properly tested were laid within 3 months of the death by tuberculosis of her male (*St. alba*) consort. The infertility of these 4 eggs is, therefore, of little or uncertain significance (see table 29). This female is most remarkable for having

⁶ See Chapters V-VII, Volume I.

⁷ This pair gave rise to the series of end-of-the-season "mutants" described and figured in the preceding chapter.

laid 15 clutches of eggs, with 1 egg only in a clutch! She has never laid a clutch of 2 eggs, and no other known member of her species has a comparable history. The fourth female (489) was not very thoroughly tested. During her 20 months of life she laid no eggs, or only one at most, and was thus certainly less *fecund* than the 3 females which had preceded her. The fifth female (429) when well tested showed, both with *orientalis* and with *alba*, a very low percentage of fertility, the percentage, too, being higher with the former than with the latter. The sixth, seventh, eighth, and ninth females, the last of the year, all had sufficient opportunities to mate without doing so. The length of life of these birds was less than that of birds from the first of the season, but females 500 and 433 (first and third of the season) had each produced many young before they had reached the shortest of the shorter life-terms of these end-of-the-season females.

For a closer and more critical view of this situation the series of tables and the summarized complete individual histories which follow may be consulted. Many questions will arise, the answer to which can be found in definite dates and details presented there.

FERTILITY OF FEMALES OF THE SERIES.

The females of the series will be considered first. It has already been pointed out that the most fertile member of this family was female No. 500, which is at the same time the first or earliest of the females of the list. On April 13, 1912, this bird laid her first eggs (only 10 months old) before her removal from her winter quarters with other *T. orientalis*. On April 24, 1912, she was placed with a *St. alba* that proved to be a female; they seem to have mated and each soon laid (4) eggs. Neither of these first eggs had opportunity to be fertilized. These and several others from the series of 1912 and 1913 were used for other studies. Late in May of her first breeding season she was given a male *St. alba*; from this pair 21 additional eggs were obtained during the season. The fertility of 15 of these was tested. The fourth, fourteenth, and sixteenth of the series were infertile. 12 young hatched and practically all are alive at the end of 3 years (table 43).

During 1913 the same pair produced 28 eggs and 15 young, 3 eggs again testing infertile. Her mate died of tuberculosis November 24, 1913. A new *St. alba* (nearly pure) mate was given April 1914. From this pair (till March 20, 1915) 50 eggs have been obtained. All except 4 broken ones have been tested; 2 of these broken ones are known to have contained live embryos, and 2 showed no development whatever. These latter were the twenty-first and twenty-third eggs of the season (August 7 and August 22). Two full-term embryos died from faulty incubation, and 1 egg showed only a trace of development. Nearly all of the young of 1913 and 1914 are also still alive (tables 43 and 44) at the time this is written. It is clear, therefore, that this female—the first female of the season—was by far the most fertile of the entire family to which she belonged. Her very long breeding record is placed in the following chapter because of its bearing on subjects discussed there.

The short earlier statement, together with table 29, supply all that it is necessary to present concerning No. 481, the second female of the season. Likewise the very full treatment accorded in the preceding chapter to the offspring of the third female (No. 433) sufficiently presents the degree of fertility of this bird. It was there noted (table 20) that even with a weakened "mutant" inbred male

(108), half of her eggs were hatched, and several other eggs showed well-developed embryos. The fourth female (489) lived 20 months and laid no eggs.

The fifth female (429) was left with other male and female *T. orientalis* until 15 months old without indication of desire to mate. Early in May 1913, however, this bird while unmated laid her first eggs. She was thereafter mated with a *St. alba* (672); the mating proved very infertile. She was remated September 30, 1913, to learn whether she would prove more fertile with a male (69) of her own species. It will be noted that very many of her eggs had peculiar shells—roughened with calcareous nodules, or were soft and defective. That maternal instincts were also awry in this female is shown by habitual egg-laying from the perch. A comparison of the data of the two matings (table 30) shows that when female 429 was mated with a male of her own species she was very plainly more fertile than when mated with *St. alba*.⁸ From this latter mating only one egg of 17 tested showed any trace of development; this one hatched. The mating with one of her own species, though a brother to her father, yielded eggs showing some development in 7 of the 9 tests; 2 of these developed near to hatching. The considerable numbers of untested eggs, usually broken or defective, were used in other studies.

The sixth female (454) lived for 19 months, and although constantly with males of her own kind she laid no eggs and showed no signs of mating. The seventh (475) has a similar history. The eighth and ninth females had a slightly shorter term of life, but like the preceding remained with their mature brothers without producing eggs, and without showing any indication of their sex, or of desire to mate.

FERTILITY OF MALES OF THE SERIES.

Three of the 7 known males showed no signs of mating and never won mates; this evident deficiency of Nos. 452, 412, and 488 is all that was learned of them. It has been noted that 5 of the known females show a similar history. It may here be added that 3 members of this family escaped or disappeared without having revealed their sex by means of eggs or mating behavior. Successful tests were made of the fertility of 4 males; 3 proved absolutely infertile. Reference to these tests will be made after the single case of partial fertility is described.

The original data on the fertility of male 421 is given in table 31. The bird was tested with 3 different females. He mated when only a year old, but at this time (1912) only the slightest fertility was in evidence. Even in the earlier months of 1913 fertility was still too low. Finally, all of the 20 eggs from the mating of 1914 were absolutely infertile, though the birds were frequently seen to copulate. On July 16 it was decided to replace this male with a *St. alba* (715) to see whether the complete infertility might be traceable in part to the female. That this was not so is shown by the record (table 32), from which it appears that notwithstanding the lateness of the season and the previous overwork, this female was still fairly fertile with the new male. There can therefore be no doubt whatever that "weak sperm" of male 421 is responsible⁹ for the uniform lack of development in the earlier part of the season. No. 421 acquired his weakness by inbreeding and through his origin from an egg produced late in the season, under conditions

⁸ Possibly part or much of this difference in fertility for two successive years may be due to ageing; it is unsafe to press such comparisons very far.

⁹This male died January 1915 (very tubercular); it had no right testis discoverable at autopsy; a diminutive left testis; a very large tubercle involving whole of spleen, and possibly the whole of another left gonad.

of "crowded reproduction." The *St. alba* male (715), which was tested with the above female, was produced under similar seasonal conditions as the inadequate male 421; but the former was not an inbred. When bred to his sister a considerable proportion of the eggs developed¹⁰ (table 32). The trace of fertility found in 421 is, however, the only trace that will be found among the 7 known males of the series.

Male 464 proved wholly infertile in 6 successive tests with a *St. alba*, as is shown in detail in table 33. Similarly male 440 was as completely infertile with *St. alba* in 13 successive tests (table 34). The complete infertility (in 5 tests) of the male last to be considered (446) is recorded in table 35. In this case the female (*St. alba*) used in the cross was tested immediately before and immediately after her infertile union with 446. The earlier mating was with a *T. orientalis* male, a brother to 446, but from the previous year; in the later mating a male *St. alba* was used. In both of these matings the tests proved fully fertile. Male 446 was therefore wholly responsible for the 5 infertile eggs produced during his mating period.

It will be of interest to present here the record for 1913 of the female used in the three matings just described in connection with the fertility tests of male 446. In the first place, this will better show how completely fertile was the female with which that bird was so completely infertile; and secondly, the data will be seen to reflect, in the offspring of overworked *St. alba* parents, some of the features which until now we have considered in *T. orientalis* only.

The data recorded in table 36 bring out the following points:

(1) The fertility of 31 eggs was tested. The first 22 of these were fully fertile; the twenty-third and twenty-fourth were able to reach full embryonic development but unable to hatch; the "first" egg of the following clutch was fully fertile, while its mate produced only a four-day embryo (imperfect shell may or may not have caused this). The following clutch contained an infertile and a broken egg; the next an infertile and a fully fertile egg which produced a bird, probably weak; it died 16 days after hatching, and presented at that time no well-defined sex-glands. The last of the 31 eggs tested for fertility produced a 6- to 8-day embryo. A total of 51 eggs were produced during the season. Those not accounted for in this table were used in other work (chemical analysis).

(2) Seven of 16 eggs laid before July 1 and incubated, produced males; 3 produced females. After July 1, 3 males and 4 females were hatched. Though these numbers are not large, they are in both cases similar to those of the previous year (table 35).

(3) The two clutches which immediately precede the first unhatchable clutch both produced males from the first and females from the second egg.

(4) The sex-glands of a 1-month-old bird from the end of the season (September 23) were largely or wholly undeveloped.

(5) Though the data for length of life are not yet complete, many birds being still alive, it is clear that the later eggs of the season gave rise to birds of shorter life-terms. The "seasons" in the previous year (table 35) also bear a similar relation to longevity in addition to sex, as noted above.

(6) These results obtain from a mating that approximates to a mating of two individuals of the same species, the female being a $\frac{3}{4}$ *alba* \times $\frac{1}{4}$ *risoria* hybrid. It is evident that the great decrease in fertility at the end of 1913 was largely due to reproductive "overwork," though the predominance of males at the beginning of the season and the general vitality of the young were possibly somewhat influenced by the slight element of crossing which is also involved.

¹⁰ This second male also died of tuberculosis on March 1, 1915.

Condensed and consecutive record of matings made to test fertility of offspring of this family.¹¹

♂ 452. 5/16/11-5/16/13; 24 mo.

When a year old this male placed with *St. alba* 409 (also one year old) which had just laid (while unmated) her first clutch of eggs. These birds remained together until September 3, 1912, without mating. Female 409 died November 15, 1912. After September 3, 1912, 452 was placed with *T. orientalis* (2) then at least 15 years old; no result (♀ died November 17, 1912). During the succeeding winter (and spring) of 1912-13 this male was with several *T. orientalis* (including ♀ 475) of similar age but without result.

♂ 446. 5/16/11-2/21/13; 21 mo.

When 1 year old (June 25, 1912) put with *St. alba* female 414 (then nearly 1 year old). Five eggs produced, all infertile; this, with a female that tested very fertile earlier, and also later, in the same season, with *T. orientalis* 101 and with *St. alba* 26, as is fully shown in table 35.

♂ 412. 6/11/11-3/25/13; 21½ mo.

When a year old was placed for a time—probably the whole summer—with female 481 of this series without result. During the winter of 1912-13 (till death) was with a group of *T. orientalis*, probably without securing a mate.

♀ 500. 6/11/11; alive 10/1/14; 40+ mo.

The very considerable data on this bird will not be presented here in full, nor in tabular form (it would require three full-page tables), since these must be presented in a work of our own (O. R.) soon to be published, in which chemical and other aspects of the ova are studied in much detail. To March 20, 1915, she had hatched 59 young, and only 9 infertile eggs have been found. More than 100 eggs have been produced. Nearly all her young are still alive.

♀ 481. 6/25/11; alive 10/1/14; 40+ mo.

The complete record of this bird is given in table 29.

♀ 433. 7/18/11-11/27/13; 28 mo.

This record is completely given in table 20.

♀ 489. 7/16/11-3/28/13; 20 mo. 20 da.

When 1 year old this bird was put, for about 6 months, with *T. orientalis* 481; probably with no result. It was at first thought that these birds were mated (in general pen) before being given a separate cage, and thought too that 489 had laid an egg, this probably wrong. From November 1912, till death, March 28, 1913, with several *T. orientalis* males without result. This bird was therefore by no means the equal of her sisters 500 and 433 in fecundity nor in desire to mate.

? ♂ 440. 7/26/11; disappeared 10/24/12-12/1/12; 16+ mo.

The short mating history of this male is presented in table 34. Sex known only from behavior.

? ♂ 424. 7/26/11; disappeared before 5/1, 12; 10+ mo.

428. 8/6/11; escaped before 12/1/12; 16+ mo.

For 4 months (after a year old) this bird had opportunity to mate with both male and female *T. orientalis* without doing so. Its escape prevented the ascertainment of its sex.

♀ 429. 8/8/11; alive 1/1/15; 41+ mo.

During summer, autumn, and winter of 1912 with two brothers—412 (until January) and 488—without eggs and with no indications of mating. On May 7, 1913 (mated to *St. alba* 672) she began laying eggs, nearly all of which were infertile; during the following year laid mostly clutches of one egg each (infertile); breeding record in table 30.

? ♂ 464. 8/14/11; alive 10/1/14; 38+ mo.

When a year old this bird was kept for about 6 months with a sister female 436 without result. *St. alba* female 892 was given April 30, 1913. Table 33 supplies the details of this infertile union, and later failure to mate.

414. 8/16/11; disappeared before 12/1/12; 16 mo.

This bird was kept with some of its brothers and sisters without mating. Its escape left the question of its sex undetermined.

♀ 454. 8/22/11-3/24/13; 19 mo.

Like the preceding, this bird remained with the other sex of its own species without mating.

♀ 475. 9/1/11-3/23/13; 18 mo. 22 da.

This bird was kept with its older brother, 452, from early November 1912 till time of death, with no indication of mating.

♂ 421. 9/15/11-1/15/15; 39½ mo.

The full history is given in table 31. The sex-glands abnormal; probably a single testicle.

♂ 488. 9/15/11-4/23/13; 19 mo.

This bird kept with some of its sisters during its whole life; it did not mate.

♀ 436. 9/26/11-4/5/13; 18 mo.

During the 6 months preceding its death, female 436 was kept with its brother 464 without result.

♀ 423. 9/28/11-2/21/13; 17 mo.

This bird, the last hatched of the series, was continuously with one or more of its brothers without having mated or laid eggs.

¹¹ The birds are here listed in the order of hatching.

SUMMARY.

It is elsewhere shown that the germs of pigeons produced late in the season, particularly when the parents have been made to overwork at reproduction, have lower developmental power than have the earlier produced gametes from the same parents. It is also elsewhere shown that the sex-ratio and the longevity of the young produced from such eggs with lowered developmental strength are modified—more females and a shorter life-term result from such gametes. In this chapter is presented the issue of a thoroughgoing comparative test, made upon a large family of Japanese turtle-doves, which had as its purpose the definition of the limits of fertility of each of the several members of the family, and thus to learn whether those individuals which were themselves developed from germs of different levels of developmental power, according to season, do or do not in their turn show, deliver, or transmit their own particular level of developmental strength or fertility to their own germs.

TABLE 28.—Condensed sketch showing relative fertility of *T. orientalis* offspring, 1911.

Nos. in order of hatching. ¹	Length of life.	Opportunities to mate with <i>T. orientalis</i> .	No. of eggs. ²	Opportunities to mate with <i>St. alba</i> .	No. of eggs.	Fertility.
♂452	Dead, 24 mo.	w. very old ♀ (2) w. sev. ♀'s, 6 mo. (♀ 475)	0 70	409 (sick), 2 mo.	0	0
♂446	Dead, 21 mo.	w. ♂ 201, 6 mo.	0	414, 4 mo.	5	No development.
♂412	Dead, 21½ mo.	w. sev., 6 mo. (481)	0			
♀ 500	Alive, 40+ mo.			410, 19 mo. 767, 7 mo.	49 30	27 hat.; 6 infertile; 16 not tested. 24 yg.; 2 broke w. emb.; 2 infertile; 2 not tested.
♀ 481	Alive, 40+ mo.	421, 3 mo. ♀ 489, 6 mo. 412, 5 mo.	0 0 1	215, 13 mo.	14	Only 4 (w. alba) tested; all infertile
♀ 433	Dead, 28 mo.	108, 12 mo. 69, 4½ mo.	28 0			1 w. <i>T. orient.</i> ; not tested.
♀ 489	Dead, 20 mo.	w. sev., 4 mo. w. ♀ 481, 6 mo.	0 70	672, 2 mo.	0	12 yg.; 4 emb.; 4 infertile; 8 not tested.
*♂440	Eseaped, 16 mo.			430, 5½ mo.	16	14 absol. infertile; 2 not tested.
424	Disappeared, 10 mo.					
428	Eseaped, 16 mo.	w. sev., 3 mo. w. sev., 3 mo.				
♀ 429	Alive, 38+ mo.			672, 4½ mo.	24	w. <i>St. alba</i> , 6 not tested; 16 absol infertile; 1 hatched.
		(69, 12 mo.)	23			w. <i>T. orient.</i> , 14 not tested; 2 no dev.; 7 emb., 2-14 da.
♂464	Alive, 38+ mo.	436, 6 mo.	0	892 682	10 0	6 tested; all absol. infertile.
444	Disappeared, 16 mo.	w. sev., 3 mo.				
♀ 454	Dead, 19 mo.	w. sev., 6 mo.	0			
♀ 475	Dead, 18 mo.	w. sev., 6 mo., ♂ 452	0			
♂421	Dead, 39½ mo.	481, 3 mo.	0	602, 10 mo. 744, 4 mo.	11 20	4 yg.; 4 no dev.; 3 not tested; 20 absol. infertile.
				437, 6 mo.	4	a 2 and a 4 da. emb.; 2 absol. infertile.
♂488	Dead, 19 mo.	w. sev., 6 mo.	0			0
♀ 436	Dead, 18 mo.	464, 6 mo.	0			
♀ 423	Dead, 16 mo.	w. sev., 6 mo.	0			

¹ Where brackets are placed, the order within the clutch is not known.² That is, eggs by the female of the pair as mated.

The data demonstrate that among these individuals the strongest germs—the germs of highest efficiency in the accomplishment of development—were produced by the earlier birds of the season. The two individuals from the *very first* eggs of the season, and those from the last several eggs of the season, were completely or almost completely infertile. Almost completely fertile birds (females) arose from the early season. There appears in these results, moreover, a higher degree of fertility in the females than in the males. The probable bearing of this fact has been already pointed out. The data indicate, therefore, that the low levels of fertility, attained by experimental means—late season with overwork—are levels which not only influence the sex of offspring as shown elsewhere, but that the function of fertility which is thus forced to new levels tends to propagate itself in inheritance upon such newly formed or enforced levels.

TABLE 29.

σ^3 215 St. alba 1909-10; 6/14/14; 48+ mo.
 σ^3 412 T. orientalis; 6/11/11; 3; 15 13; 21½ mo.
 φ 481 T. orientalis; 6/25/11; alive 10/1/14; 40+ mo.

In summer of 1912 this female was with φ 489; winter 1912-13 with brother 412; σ^3 412 died 3/15/13 (unmated).

St. alba σ^3 215 given 5/1/13.

A. 3/20/13; (eold) (first in life).

B. 5. 14 13; not incubated. ¹	E. 6. 5. 13; from perch and broken. ²
C. 5. 23; not incubated.	F. 8/5; from perch and broken.
D. 6. 1; not incubated.	G. 8. 9-10; from perch and broken.
A. 1. 2/14; not incubated.	E. 3. 26; no trace development.
B. 1. 27; not incubated.	F. 4. 11; not incubated.
C. 3/8; not incubated.	G. 5/2; no development.
D. 3/16; no trace development.	H. 5. 28; no development.

σ^3 715 St. alba; 8/28. 13; alive 10, 1, 14; 13+ mo.

This male given 6/16/14, when it was active and fertile. On 7/16 (unmated), removed, and her brother (421) given; no result; σ^3 421 died 1/1/15. (O. R.)

¹ Advantage was taken of the opportunity here offered to study the size relations of the egg-yolks of a female that laid clutches each of a single egg.

² The nesting habits of this bird were never normal. Several of her eggs were slightly broken.

TABLE 30.

σ^3 St. alba (672); about August, 1912 (from dealer); 4. 17/14; 21½ mo.
 φ T. orientalis (429); 8/8. 11; alive 10/4/14; 3+ yr.

A 1. 5. 11/13; first in life; shell roughened with calcareous nodules.	I. 7/26/13 (bird confined) no development.
A 2. 5. 12/13; soft shell.	J. 1. 8/4; no development.
B 1. 5/27; from perch; broken.	J 2. 8/6; no development.
B 2. 5/29; not tested.	K. 8. 13; no development.
C. 6/6-7; from perch; broken.	L. 8. 16 or 17; from perch, broken.
D 1. 6/14; no development.	M 1. 8. 23; no development.
D 2. 6/16; no development.	M 2. 8. 25; no development.
E 1. 6. 22; from perch; broken.	N 1. 9/3; no development.
E 2. 6/24; no development.	N 2. 9/5; on ground, no development.
F 1. 6/30; no development.	O 1. 9/13; no development.
F 2. 7/2; no development.	O 2. 9/15; no development.
G 1. 7/10; from perch; broken.	(O. R.)
G 2. 7/12; no development.	
H 1. 7. 18; from perch; broken.	
♀ H 2. 7/20; white; 714; dead 11/26/13; 4 mo. 6 da.	

TABLE 30 (*continued*). σ^3 69 T. orientalis; 7, 17 06; alive 10/1/14; 8+ years. (given 9/30/13).

A 1. 3/16/14; not tested.	I. 6/4/14; not tested.
A 2. 3/18/14; not tested.	J. 6/15/14; not tested.
B. 3. 25; imperfect shell; 4 day embryo.	K. 6/23; not tested.
C 1. 4/6; imperfect shell; 5 to 6 day embryo.	L. 7/14; soft shell; not tested.
C 2. 4/8; from perch; broken.	M. 7/27; not tested.
D. 4/19; imperfect shell; 8 to 9 day embryo.	N. 8/12; cracked; 10 day abnormal embryo.
E. 4/27; imperfect shell; 3 day embryo.	O. 8/25; imperfect shell; cracked; live 3 day embryo.
F 1. 5/6; 13 day abnormal embryo.	P 1. 9/4; not tested.
F 2. 5. 8; not tested.	P 2. 9/6; not tested.
G. 5/18; no development.	Q 1. 9/19; not tested.
H. 5. 29; no development.	Q 2. 9/21; not tested.
	R. 10/4/14; not tested.
	(O. R.)

TABLE 31.

 σ^3 T. orientalis (421); 9/15/11; dead 1/1/15; 29½ mo.♀ St. hybrid (437); white ($\frac{1}{4}$ alba, $\frac{3}{4}$ risoria); early 1911; 11/23/12; 18 mo.

This pair put together 4/24/12; ♀ had already laid 2 clutches; first in life.

C 1. 6/30/12	one 2 day embryo; other a 4 day embryo.	D 1. 7/13; no development.
C 2. 7/2/12		D 2. 7/15; no development.

♀ 602 St. alba from dealer 1. 31/13; 3 8/14; 1½ yr. (?)

♀ was 4 to 8 mo. old when bought. Purity? This pair together 5/19/13.

1. 5/23/13; broken.		
J 1. 7/3; no development.		
J 2. 7/5; no development.		
♀ L 1. 7/27.....dark.....713.....dead 8/17/14.....		12½ mo.
L 2. 7/29.....dark.....	dead 8/14/13.....	16 da.
M 1. 8/9; egg stolen.		
M 2. 8/11; egg stolen.		
♀ N 1. 8/24.....dark.....752.....dead 12/17/13.....		3 mo., 24 da.
♂ N 2. 8/26.....dark.....768.....alive 8/1/14.....		11+ mo.
O. 9/11; no development.		

♀ 744 St. hybrid $\frac{1}{2}$ (or nearly) alba, $\frac{1}{2}$ risoria; 3, 3 13; alive 8/1/14; 17+ mo.

This ♀ given early 1914.

A 1. 4/21/14; no development.	E 1. 5/26; no development.	I 1. 6/30; no development.
A 2. 4/23/14; no development.	E 2. 5/28; no development.	I 2. 7. 2; no development.
(A 1. First egg in life.)		
B 1. 4/29; no development.	F 1. 6/3; no development.	J 1. 7/11; no development.
B 2. 5/1; no development.	F 2. 6/3; no development.	J 2. 7. 13; no development.
C 1. 5/7; no development.	G 1. 6/14; no development.	
C 2. 5/9; no development.	G 2. 6/16; no development.	
D 1. 5/16; no development.	H 1. 6/22; no development.	
D 2. 5/18; no development.	H 2. 6/24; no development.	
		(O. R.)

TABLE 32.

 σ^3 715 (7, 8 alba); brother; 8/28/13; dead 3/17/15; 19 mo.

♀ 744 (7, 8 alba); sister; same as preceding table.

K 1. 7. 22/14; 2 day embryo.	
♀ K 2. 7/24/14.....white.....60.....alive 9/15/14.	
L 1. 7/29.....white.....33.....alive 9/15/14	
L 2. 7. 31; 3 day embryo.	
? ♀ M 1. 8. 5; pipped; failed to hatch.	
M 2. 8. 7; slightly broken; some development.	
N 1. 8/14.....white.....alive 9/15/14.	
N 2. 8/16.....white.....alive 9/15/14.	
O. 9/19; no development.	

(O. R.)

TABLE 33.

 σ° T. orientalis (464); inbred; 8 18; 11; alive 10 1, 14; 3+ yr. φ White (892); 11, 1/12; 4/30, 14; 1 yr. 5 mo. φ 892 = $\frac{1}{2}$ alba (or nearly) and $\frac{1}{2}$ blond. First clutch laid while mated with a φ alba.A. 4 25 13 (first in life); not incubated; (φ mated with φ).

B 1. 5 26 13; not tested.	D 1. 7 18; no development.	F 1. 11 28; broken.
B 2. 5 28 13; not tested.	D 2. 7 20; no development.	F 2. 11 30; not incubated.
C 1. 6 22; no development. ¹	E 1. 8 23; no development.	9 killed 4/30, 14; tuberculosis.
C 2. 6 24; no development.	E 2. 8 25; no development.	(O. R.)

¹ These birds were rather too young for fertility to be at its greatest height in either. But the male was a weakened inbred from an egg produced rather late in the season from an overworked pair. The female of the above pair became tubercular, probably after most or all of the above eggs were laid. During the season of 1914 this male was kept with a mature female St. alba (682) without any eggs whatever being produced. Thus we see another evidence of the weakness of this male when in his third year.

TABLE 34.

 $440 \sigma^{\circ}$ T. orientalis (inbred); 7/26/11; disappeared 10/24/12 to 12 1/12; 16+ mo. 430φ White = $\frac{1}{2}$ alba, $\frac{1}{2}$ risoria; 8/16/11; 2 2, 13; 1 $\frac{1}{2}$ yr.

Put together 4/17/12.

It is possible, but hardly probable, that this female had laid 1 or 2 pairs of eggs during the preceding winter.

A 1. 7 4/12; not tested.	D 1. 8/1; no development.	G 1. 8/31; no development.
A 2. 7, 6, 12; not tested.	D 2. 8/3; no development.	G 2. 9/2; no development.
B 1. 7, 13; no development.	E 1. 8/10; no development.	H 1. 9/12; no development.
B 2. 7/15; no development.	E 2. 8, 12; no development.	H 2. 9, 14; no development.
C 1. 7/23; no development.	F. 8/19; no development.	
C 2. 7/25; no development.	(No second egg.)	

(O. R.)

TABLE 35.

 σ° 101 T. orientalis; 5 26 10 (inbred); escaped 6/23, 12; 25+ mo. σ° 446 T. orientalis; 5/16/11 (inbred); 2, 21/13; 21 mo. 5 da. σ° 26 St. alba ($\frac{1}{2}$ alba, $\frac{1}{2}$ risoria); 4/17 14; 30 to 96 mo. φ 414 St. alba hybrid; 8/6/11; 3, 17/14; 31 mo. 11 da.

From 4/24/12 to 6/23/12 T. orientalis No. 101 was used as male parent; 6, 25 to 10/11/12 T. orientalis 446, a younger brother to 101, was used. With σ° 446 it will be noted that this female was quite infertile. With the more mature brother all her eggs (4) developed; two of these whose sex is known were males. Later in the season this female (St. alba hybrid) mated with a St. alba produced mostly fertile eggs—4 of 5 tested—and 3 young from this season and mating were females; a fourth young was probably a male.

σ° 26 has not a perfectly clear history; it is probably a pure St. alba, about three years old; but possibly he is a $\frac{1}{2}$ alba, $\frac{1}{2}$ risoria hatched in 1906. Very pugnacious.

φ 414 = a $\frac{1}{2}$ alba, $\frac{1}{2}$ risoria. In breeding behavior these two birds resemble two pure alba (all of their 27 young, 1913 to 1914, were white).

 σ° 101 T. orientalis is a brother (from 1910) to σ° 446.

A 1. 6 2/12; not tested.		
A 2. 6 4 12; not tested.		
B 1. 6 7/11.....	dark.....	822..... stolen summer 1912.
B 2. 6, 13.....	dark.....	dead 6 27 12 (not fed).
σ° C 1. 6 20.....	dark.....	846..... alive 4 1/15..... 33+ mo.
σ° C 2. 6 22.....	dark.....	851..... alive 4, 1/15..... 33+ mo.

 σ° 446 T. orientalis.

D. 7/4 12; no development.	E 1. 7 29; no development.	F 1. 8/22; no development.
	E 2. 7/31; no development.	F 2. 8 24; no development.

 σ° 26 St. alba.

G 1. 10 22; not tested.		
G 2. 10/24; not tested.		
φ II 1. 11/1.....	white.....	892..... dead 4/30/14 18 mo.
? σ° II 1. 11/3.....	white.....	..... 11/29/12 (cold).
I. 11 16; developed only a "blood circle."		
φ J 1. 11 28	white.....	838..... dead 12/20/13..... 12 mo. 23 da.
φ J 2. 11/20.....	white	817..... dead 10/9, 14..... 22 mo. 9 da.

(O. R.)

TABLE 36.

σ^{α} St. alba ($\frac{1}{2}$ alba, $\frac{1}{2}$ risoria of 1906, or pure alba) (26); 1906 (?) 4/17/14; 30 to 96 mo.	
σ^{α} St. alba hybrid ($\frac{1}{2}$ alba, $\frac{1}{2}$ ris.) (414); 8/6/11; 3/17/14; 19 mo.	
σ^{α} and σ^{β} E 1. 3/2/13\} {744 σ^{α} alive 1/15/17	47+ mo.
E 2. 3/4/13} {751 σ^{α} dead 4/8/14	13 mo. 4 da.
σ^{α} F 1. 3/13	dead 4/6/14
F 2. 3/15; partly helped from shell at 16 days, failed.	12 mo. 23 da.
σ^{α} G 1. 3/22	(killed with gonad extract) 10/14/14.
σ^{α} G 2. 3/24	dead 2/7/14
J 1. 5/6; fertile; killed.	10 mo. 13 da.
J 2. 5/8; fertile; killed.	
σ^{α} L 1. 5/29	dead 8/9/16
L 2. 5/31	disappeared 7/3 13-2 11 14
σ^{α} M 1. 6/6	alive 1/15/17
σ^{α} M 2. 6/8	dead 4/12/16
N 1. 6/14; not fed; dead 7/16/13.	43+ mo.
N 2. 6/16; not fed; dead 7/15/13.	35 mo. 4 da.
σ^{α} and σ^{β} O 1. 6/22\} {767 σ^{α} dead 9/27/16	39 mo. 4 da.
O 2. 6/24\} {722 σ^{α} dead 4/9/15	21 mo. 16 da.
σ^{α} P 1. 7/1	dead 4/3/15
σ^{α} P 2. 7/3	dead 9/29/14
σ^{α} Q 1. 7/9	dead 6/27/14
σ^{α} Q 2. 7/11; (poor care?) dead 8/8/13.	11 mo. 18 da.
σ^{α} R 1. 7/17	dead 9/14/16
σ^{α} R 2. 7/19	dead 2/10/15
V 1. 8/20; incubation 17 days; ¹ partly opened, alive; died few hours, very small (1.80 g.), size of 12 day embryo.	19 mo.
V 2. 8/22; incubation 16+ days; not pipped, but probably full-term embryo.	
σ^{α} W 1. 8/28	dead 3/17/15
W 2. 8/30; imperfect shell; 4 day embryo.	19 mo.
X 1. 9/12; no development.	
X 2. 9/14; broken.	
Y 1. 9/21; no development.	
Y 2. 9/23; hatched, starved (?); dead 10/23/13, but sex not evident in this 1 mo. old bird!	
Z. 10/8/13; 6 to 8 day embryo.	(O. R.)

¹ This egg should have hatched at 15 days.

CHAPTER VII.

CROSSES OF JAPANESE TURTLE DOVES WITH BLOND AND WHITE RING DOVES.¹

The considerable number of tables presented here will serve in general for reference in connection with the condensed account of fertility and sex as given in Chapter II. More particularly, they offer: (1) an opportunity to compare crosses which are intermediate to the "distantly related and the closely related" forms of Chapter IV; (2) they show again the effects of season and overwork on fertility, longevity and sex; and (3) they present the following additional features not hitherto considered:

(A) The good effects of crossing related genera as seen in (a) the long term of life of the offspring; (b) the development of all, or nearly all, of the eggs; (c) the predominance of males from the eggs of the spring and early summer and from "uncrowded clutches" generally.

(B) It will be seen (a) that the two eggs of the clutch of the pure females have different sex tendencies, and (b) that there is some evidence that unpaired eggs (*i. e.*, eggs from clutches of one egg only) apparently have stronger sex tendency than have the paired eggs, in that they are more *independent* of season and overwork, in their production of sex, than are the paired eggs.

(C) The fertility of hybrids from these related genera present the following situation: (a) The hybrids crossed *inter se* or with their parent species are usually less fertile than was the original cross, their young live less long, and the sex of the offspring is probably less dependent upon season and overwork, and certainly bears little or no relation to the order of the eggs in the clutch; (b) eggs from matings of complex hybrids are probably more fertile than from matings of F_1 *inter se*, or from F_1 with the parent species; the term of life is probably also longer than from that cross, though this term is shorter than that for the F_1 individuals themselves.

(D) The further breeding of the F_1 hybrids and also of complex hybrids, produced a high percentage of (a) abnormal young, and (b) of *hermaphrodites*.

(E) The crosses of *St. alba* and of *St. risoria* with *T. orientalis* show that color is here a sex-limited character.

¹ The text of this chapter was written by the editor; nearly all of the tabulated data are those of the author.

EXPLANATION OF PLATE 8.

A. Adult female white ring-dove, *Streptopelia alba*. $\times 0.5$. Rowland del., Sept. 1914.

The ring has been over-emphasized in its depth of color.—ED.

B. Adult female blond ring-dove, *Streptopelia risoria*. $\times 0.5$. Hayashi del.

View of entire bird. The three separate feathers are (from left to right) the extreme upper, middle, and lower parts of the ring or neck-mark. The general color could be described as a pale fawn, or isabelline, which becomes lighter on the throat, and fades out towards and around the vent, passing imperceptibly into the white of the under tail-coverts. The black ring is sometimes narrower at its middle on the back of the neck than at the ends. This fact, together with the complete interruption of the ring on the back of the neck in the first plumage (by which it is broken into two portions, one on each side of the neck, beginning a little below and behind the ear-coverts and growing narrower backward), suggests that the half-ring has arisen by the extension of two spots like those seen in the mourning-dove. This ring is creamy-white in the "Vienna white dove" (*St. alba*). It is often reduced to a mere shadow, or wholly absent, in the first plumage.



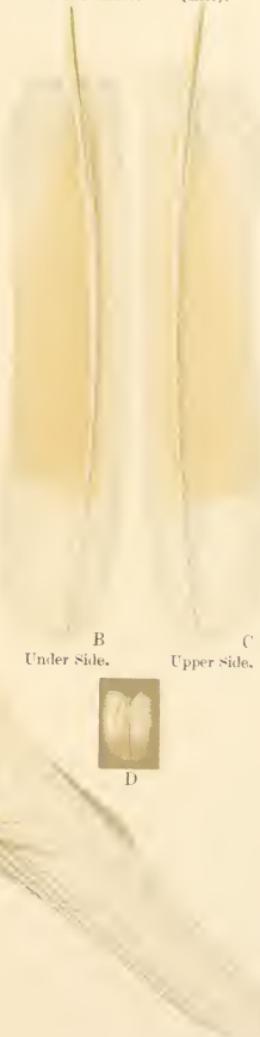
A



B

A. Adult female white ring-dove, *Streptopelia alba*. $\times 0.5$. Rowland del., Sept. 1914.
B. Adult female blond ring-dove, *Streptopelia risoria*. $\times 0.5$. Hayashi del.

Outer Tail Feather. (Left).



Adult female, *Streptopelia alba* \times *Turtur orientalis*. Hybrid (10). From egg 7-16-07. $\times 0.9$. Hayashi del., Apr. 1908.

- A. Entire bird, showing that color is not a pure "white." Dorsal coverts and feathers of neck-mark show brownish pigment.
- B. Under side of outer (left) tail-feather. That part of proximal feather which is black in *orientalis* and in *risoria* here bears a rather pale brown or isabelline. $\times 0.8$.
- C. Upper side of the same feather. $\times 0.8$.
- D. One of the more pigmented feathers of the neck-mark. Natural size.



Adult male, *Turtur orientalis* × *Streptopelia alba*. Hybrid (15). From egg 7-30-08. X 0.8. Rowland del., Aug. 1914.
Compare the lighter color of this bird with the darker shade of a half-sister, plate 11.



Adult female, *Turtur orientalis* \times *Streptopelia alba*. Hybrid (27). From egg 6-16-09. $\times 0.8$. Rowland del., Aug. 1914.

The females of this cross are perceptibly, but not very strikingly, darker than their brothers. Compare with plate 10.

The tabulations presenting these breeding data fall more or less naturally into four groups. Those four groups will be considered after a survey of the sex-limited phenomena involved in these crosses. This order of treatment will permit the reader to become more quickly familiar with the appearance and general characteristics of the forms crossed and of the resulting hybrids.

The Japanese turtle-dove has already been seen in color in pl. 1; the white ring-dove (*St. alba*) and the blond ring-dove (*St. risoria*) are here shown in pl. 8. It will be observed that these three species are markedly different and distinct in color and color-pattern.

SEX-LIMITED INHERITANCE OF COLOR IN BLOND AND WHITE RING-DOVES CROSSED WITH JAPANESE TURTLE-DOVES.

Reciprocal Crosses of St. alba and T. orientalis.—The offspring of a *St. alba* male mated to a *T. orientalis* female are of two colors. One of these colors is quite dark (males), though not as dark as that of the female parent. It is nearly like the male of the reciprocal cross which is shown in color in pl. 10. The other color is "almost white." Indeed, unless the bird and its feathers are given more than a glance, one may overlook the traces of brownish pigment present in most body feathers, and the more than a trace of brown in the neck-mark and in the under proximal parts of the rectrices. These birds, which will be spoken of as "white," are, therefore, not pure white, as is their father.² The bird figured in pl. 9 will demonstrate, however, that this group is most sharply differentiated from the dark members of this fraternity. Text-fig. 1 gives a photographic view of a brother and sister.

Matings of these two species, with the white ring as father, have yielded 59 dark and 43 white offspring. The sex of 45 of the dark birds is known;³ they were males in every case. The sex of 40 of the 43 white birds is known; they were females in every case. The records are available in tables 23, 24, 42, 43, and 44. It is reasonably clear, therefore, that in this cross the white color of the father is exhibited by all of his daughters and by none of his sons.

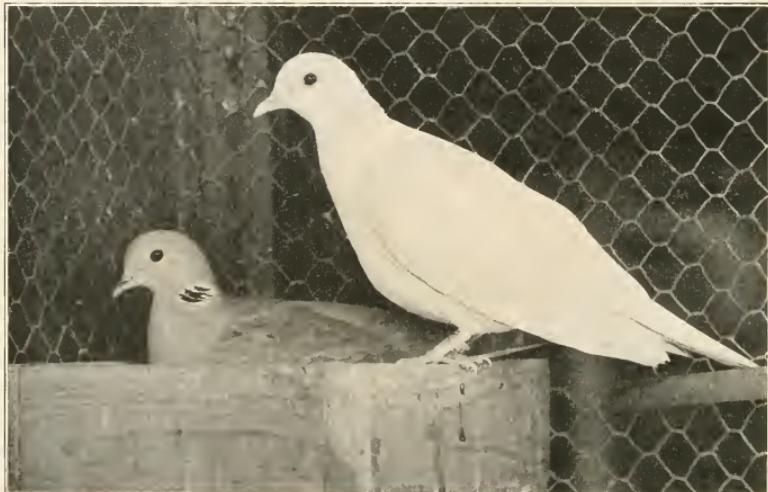
When, however, the white ring is used as the female of the cross no white offspring are produced. Sons and daughters are both of dark color. But close examination of these young shows there is a slight color difference between the males and the females. In this case the males are perceptibly lighter in color; the females a trace darker. The difference is made clear in pls. 10 and 11, which reproduce the colors of the male and female respectively. From this cross 34 males and 39 females were obtained. Tables 37 to 41 (with 25, 31, 35) present the whole of these data.

Reciprocal Crosses of St. risoria and T. orientalis.—Blond ring-dove males mated to Japanese turtle females produce young of two colors. These bear a relation to the parental colors somewhat similar to that described above for the white ring \times Japanese cross. Darker and lighter forms appear; the dark birds are all, or

² Neither of these two colors therefore represents a "pure" or complete segregation of a parental color.

³ About 10 other dark birds of this series are alive, but their sex is not yet fully tested. Where an interrogation point precedes the sex-sign in the tables referred to above, this point is intended to indicate that the sex of the bird has not yet been positively learned. Where a question mark is not followed by a sex-sign the mark usually indicates that the sex-glands of the bird were abnormal, and invites attention to a further statement concerning it. (All of the ten dark birds later proved to be males.)

nearly all, males; for example, 7 of the 8 birds listed as dark in table 47 proved to be males; the 3 birds there listed as of light color were females; but 1 female was stated to be of dark color. The data are incomplete, but it would seem that in this cross an occasional female may exhibit the dark color which is shown by all of the males. The light-colored females are not as light-colored as is the blond-ring parent; but as may be seen in pl. 12, the color, the color-pattern, and particularly the neck-mark, all afford evidence of the strong influence of the Japanese parent.



TEXT-FIGURE 1.—Adult *Streptopelia alba* \times *Turtur orientalis* hybrids—male and female (brother and sister; see table 42, under 7 and 5).

The white bird is the female; the dark is the male. The colors contrast strongly and are sex-limited in inheritance.

In a cross of Japanese males and blond ring females the relation of sex and color in the offspring is not quite clear. It is certain that all of the young are relatively dark in color. A male of this series is reproduced in pl. 13. The living

EXPLANATION OF PLATE 12.

Adult male *Streptopelia risoria* \times *Turtur orientalis* hybrid (1). From egg 4 23 04 (table 47). Nineteenths natural size. Hayashi del., May, 1905.

Fig. A. \times 1. General coloration and characteristics of the entire bird.

About a dozen filoplumes are seen on the neck-spot—often one to each of the colored feathers. One plucked feather measured 13 mm. in length, its filop�me 14 mm. The latter consists of a slender hair-like shaft, arising close beside the shaft of the feather and bearing at its tip two, three, or four fine diverging barbs (?). Each barb bears irregular short barbules. The whole is white—hence conspicuous on a black background. These filoplumes are single—one for each feather; a few are found outside the spot, but only for a short distance.

Fig. B. \times 2. One feather from right side of neck-mark

Fig. C. \times 4. Filoplumes of above feather further enlarged.



Sturnopelia risoria \times *Turtur orientalis*. Hybrid (1). From egg 4-23-04. Hayashi del., May 1905.

Fig. A. Adult male. $\times 0.9$. General coloration and characteristics of entire bird, with neck-mark seen from side.

Fig. B. $\times 2$. One feather from right side of neck-mark.

Fig. C. $\times 4$. Fileplumes of above feather further enlarged.



Adult male, *Turtur orientalis* × *Streptopelia risoria*. Hybrid (1). From egg 5-8-04. × 0.8. Hayashi del., Apr. 1905.
This is one of the "dark" variety. Feathers have dark centers and light edges; centers not definitely outlined, they merge gradually into the light edge. Feather-shafts dark. Lower edges of tertials and long coverts darker reddish than are same parts of the smaller coverts. Iris red-orange; skin around eye pale with eyelids reddish; beak blackish; feet and legs purplish red. Feathers of breast pale vinous.

forms examined by the editor indicate that, similar to the *orientalis* \times *alba* cross, the females are slightly darker than the males. This situation was not adequately treated by the author, though he has noted that the "juvenal" plumage of the first-hatched female of this series (treated in table 48) was slightly "lighter" in color than her male nest-mate.

Color and Sex in F₂, Ring-Japanese Hybrids:—The very low fertility of the F₁ hybrids, and the weakness, short life and sex-abnormalities which are associated with the few gametes which do begin development, have here prevented a full elucidation of the relation of sex and color in the F₂ generation. The author's limited data bearing on this point are given in tables 49 to 52. The back-crosses with the parent species are far more fertile than are crosses made *inter se*. The very restricted life-terms and the varied abnormalities formed from these crosses afford the best of material for the study of many important problems.⁴

RECIPROCAL CROSSES OF ST. ALBA AND T. ORIENTALIS.

Several of the subjects mentioned in the introductory statement of this chapter can be best examined through a subdivision of the rather extensive breeding data into the four groups into which they can be conveniently classified. Frequent or constant reference to the complete original data as given in the tables will, however, be found quite necessary.

Orientalis male \times *alba female*.—The very complete breeding record of a male Japanese turtle mated to female white rings is given in tables 37 to 41. This includes 10 years of breeding and 11 years of the life of this particular male. Tests were made with 6 different females. A glance at the data will make it clear that the life-term of the offspring of the resulting hybrids is quite long; *longer even than that of the longer-lived parental species when its young are reared in captivity*. This we shall later see holds true also for the reciprocal hybrids.

In this fact of increased longevity in these hybrids one notes that a very important *momentum* is given to the basic and sustaining powers and processes of the organism by the "mere act of crossing" individuals of these two genera; and, having considered this point, one becomes the better prepared to interpret other unusual features of these data, particularly the data on sex. These latter features are quite probably but another aspect of the same principle which expresses itself in an increased longevity. In other words, the same thing that drives forward the life-term in all of the offspring drives forward also sex-development in all of the offspring. Germs that are not otherwise weakened may be carried by this impulse (increased vigor through a wide cross) to a higher level of sex-development than they would otherwise have attained, namely, to maleness.

Further examination of the data referred to above will show that the *fertility* of this cross is remarkably high. In 87 tests (tables 37 to 40) only 4 failed to show some development, while only 1 egg began to develop and stopped short of hatching;

⁴ The editor is making extensive studies on many subjects connected with the size, chemistry, and stored energy of the egg, and of the relation these bear to sex and fertility; on the relation of season and "crowding" of clutches to sex; and the question of the relative infertility of these hybrids. The results of these studies must appear later. The additional knowledge obtained from these sources, however, gives the editor confidence concerning some points of the present chapter which do not appear conclusive from the data available for the present volume.

3 of the 4 infertile eggs belonged, moreover, to the very first clutch of the season, while the fourth belonged to a last clutch of the season, this latter being at the same time the last clutch laid during the life of a tubercular bird. The clutch-mate to this infertile egg (table 40) produced a short-lived young, which was without trace of germ-glands. That the male parent then 10 years old also probably contributed to the weakness of these germs is attested by the result of the tests made during the following year. These latter tests are recorded in table 41, and show this 11-year-old bird to be much less fertile than when 3 to 8 years old.⁵

Three other matings of *orientalis* × *alba* have been presented earlier in another connection (tables 25, 31, 35). The females in those crosses were mated to males known to be weak in regard to fertility. In those cases many infertile eggs were present, and most of the hatched birds did not show the long term of life exhibited by the series of matings just described. Other features of the data for the *orientalis-alba* crosses will be considered along with similar data for the reciprocal cross.

Alba male × *orientalis female*.—The data of tables 42, 43, 44 (see also 23 and 30) demonstrate that the increased length of life observed in the hybrids above described is met with also in their reciprocals; the high degree of fertility observed there is again equally evident here. In the first case to be noted (table 42) it is only during the immaturity of the female parent, and at the extremes of the season, that there is notable infertility.⁶

The relation of the two eggs of the clutch to the production of sex, and the relation of season to sex, as it appears in the present data for the reciprocal crosses of *St. alba* and *T. orientalis*, may now be considered. In the *alba* × *orientalis* cross there occur 12 cases in which the two sexes arose from the two eggs of the same clutch. In 10 of these the first egg gave rise to a male, the females being produced from the second of the clutch in these same 8 cases. In 2 cases the reverse is true—the females here arose from the first and the males from the second of the clutch. From the *orientalis* × *alba* cross there were 12 clutches which produced both a male and a female. In 7 of these the first egg produced the male, the second egg the female, and in 5 cases this order was reversed; 3 of these reversals, however, came from a series (table 40) in which the female was probably not *pure alba*, and we have elsewhere already noted, and will later again refer to it, that when the female parent particularly is *hybrid*, the order of sexes from the two eggs of the clutch is quite irregular.⁷

The data for these crosses which bear upon the "shifting of dominance" of sex from spring to autumn, are perhaps not wholly conclusive. They do accord,

⁵ A similar result for the parents of this bird has been shown in table 19.

⁶ "See the young (No. 26, table 42) that failed to develop fully at the end of the season of 1908—October. This is a good case, as it comes from a pair that have been very fertile." (R 16.)

⁷ The question of the relation of the order of the egg in the clutch to the production of sex in these and other crosses has been, and is being, very thoroughly studied by the editor, who will presently report the findings in full. In these studies it has become quite clear that the *yolk-size* of eggs (of pure species) is quite closely correlated with the sex of the resulting offspring; and that *yolk-size* is usually correlated with the size of the whole egg. Whitman learned that males predominate from the first egg of the clutch (see Chapters III and XIII, and he certainly had some clear evidence that the *total size* of the first egg of the clutch was usually smaller than the second (see tables 174, 176, 177). The amount of data on this latter point (weights) is so small that it seems probable that some were in manuscripts which have *never been available* to the editor. In our own studies the complete records on the egg-size of incubated eggs indicates that in those cases where the usual order of the sexes (in the clutch) is reversed, the order of *yolk-size* in these clutches was also reversed. In other words, maleness is associated with the smaller yolks, and usually—though not always—the small yolk is found in the first egg of the clutch.

however, with the results found generally in the other crosses, and a consideration of this matter may be undertaken in connection with these data. The effects of "season" upon sex are, after all, not easily separated from other agencies, which also influence the production of sex. Chief among these latter are the matter of the "crowding" of the clutches (overwork), the strength, vigor, health, and age of parents, and the frequent relative "weakness" of the very first egg, or pair of eggs, of the season. It will be observed in these data, and in those of other similar crosses, that "pairs of males" rarely arise in the *autumn* from *crowded* clutches, i.e., from pairs of eggs produced immediately⁸ after other eggs. Likewise "pairs of females" rarely arise from the early part of the season from *uncrowded* clutches. The health and vigor of parents can not always be known in advance, and for this reason the date of death, when known, of all parents is given in the several tabulations. The very first egg or pair of eggs in any season are found to produce a higher proportion of *females* than the next few succeeding clutches; they produce also a higher proportion of infertile eggs and of short-lived offspring than the immediately succeeding clutches, and in these several ways warrant their classification as "weak" eggs.

A condensed and classified tabulation of the "shifting of dominance" of sex of the *alba* × *orientalis* crosses is given in table 45. Here an arbitrary date—July 1 in all cases⁹—is chosen as the point of separation of early and late season. It will be noted that before July 1 there were produced 29 males to 10 females; after July 1, 31 males were produced to 33 females. Of course an arbitrary date—July 1 in this case—can not represent the proper turning-point of predominant maleness to predominant femaleness in all of the 9 series tabulated, since, for example, in some series the maximum production of males continued after July 1, and this tends in the summary to make the number of "late" season males too high. The numbers concerned are not large, but it will be observed that in the "early period," where the method of lumping the data least violates the individuality of the data, 8 of the 9 series show a strong predominance of males, and the ninth series is a small one having 1 male and 1 female. In 1908 (see table 42), 3 of the first 4 eggs of the series yielded males, while the 10 succeeding eggs gave rise to 10 females. The same pair of parents during the previous year threw 4 males and 1 female before July 1, but 3 females and 1 male after July 1.

A consideration of the sex data from these crosses is not complete without reference to the evident predominance of males over females in the offspring, notwithstanding the considerable amount of "overwork" effected in several of the series. This predominance is greater in the *alba* × *orientalis* cross than in the reciprocal cross; but the average for the two is greater than when *orientalis* is mated with *orientalis* or when the latter is mated with *turtur*, which is only specifically distinct from it. *Alba* is separated generically from *orientalis*, though they are closely related genera, having been grouped formerly within a single genus. Again the predominance of males is most pronounced (Chapter IV) when *orientalis* is crossed with *Columba*, and these two forms are separated by differences of family

⁸ About 6 days is the shortest time that an egg may be produced and laid after the second egg of the previous clutch was laid.

⁹ In the record of 1908, where every egg laid was hatched and the resulting sex ascertained in every case, the division-point is April 1, after which no males were produced, but the 10 further eggs produced females in every case.

rank. It is thus shown that if *orientalis* be mated with forms progressively more distantly related to it, the predominance of males progressively increases. It is further shown that in inbred *orientalis* there is an actual predominance of females. A summary of these data is given in table 46. The data are taken from the breeding records fully given in this and previous chapters.

RECIPROCAL CROSSES OF ST. RISORIA AND T. ORIENTALIS.

The amount of data for crosses of blond rings with Japanese turtles is not large, but it coincides with the data for the very similar cross which has just been considered, particularly in the demonstration of a high degree of fertility, of great length of life of offspring,¹⁰ and of the linkage of sex and color in inheritance. The details are presented in tables 47 and 48.

PRIMARY HYBRIDS CROSSED INTER SE AND WITH PARENT SPECIES.

Most of the possible crosses of *F*₁ hybrids from white rings or blond rings and Japanese turtles have been made. When back-crossed with the parent species these hybrids usually prove somewhat more fertile than when crossed *inter se*.¹¹ The results from 11 pairs are fully shown in tables 49 to 52. In every case—in back crosses and in *inter se* crosses—fertility is low and the life-term is short. It turns out, furthermore, that of 8 offspring whose gonads were examined after death, 4 were found to be inadequately or abnormally sexed. An additional 2 or 3 of such offspring (which have functioned, apparently normally, as male or female) are still alive.

The details of these matings need not be further discussed here.¹² A reference may be made, however, to table 51, in which two Japanese turtle males are shown to have been fertile to about the same very limited degree with a *risoria-orientalis* hybrid. It is of some interest to note that in these two matings the 4 eggs of this female which showed some development were all the first egg of the clutch. Again, in table 57, where a multi-hybrid is mated with a pure *St. risoria* female, there are 5 pairs of eggs which gave rise to the two sexes. In all of these 5 cases the first of the clutch produced a male and the second a female. It now seems certain that fertility and sex problems in pigeons are closely bound up with the matter of order of the individual eggs of the clutch (particularly, however, in non-hybrids), and with the order, extent, and crowding of the clutches. When fertility is very low, as in the series first mentioned above (table 51), the longevity is much decreased; but if perchance a bird can live moderately long, as did *B1* of pair 6, it will often betray striking abnormalities; and these malformations are often associated with sex.

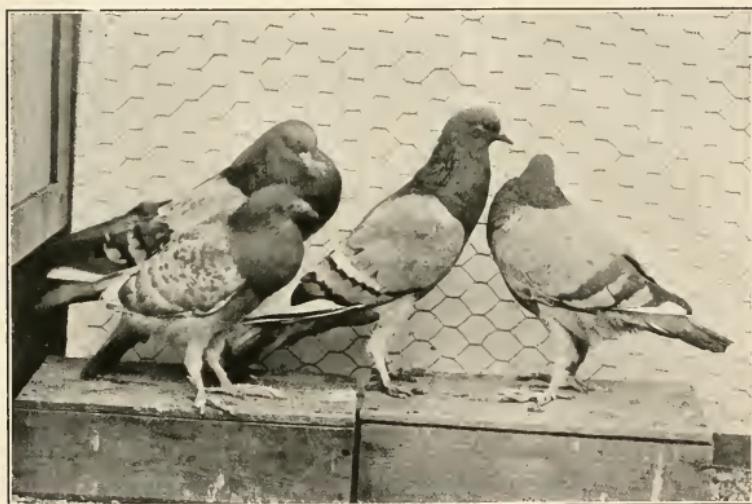
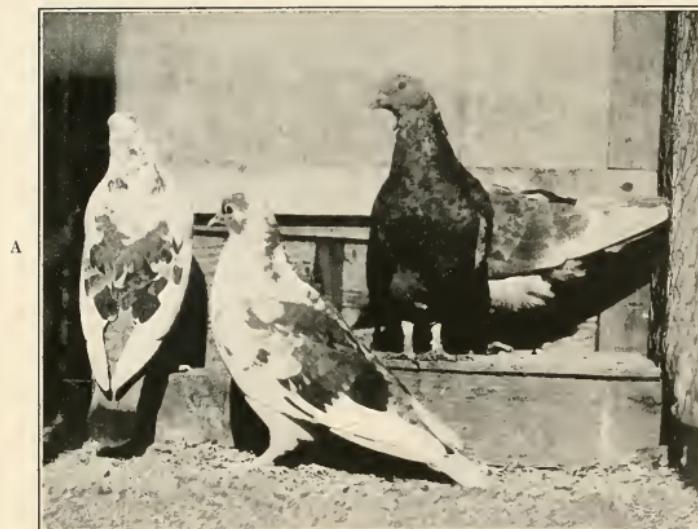
FURTHER BREEDING OF COMPLEX ORIENTALIS-ALBA-RISORIA HYBRIDS.

In tables 53 to 62 are recorded the results of a long series of matings of hybrids of the three species under examination. The data contribute in general to the thesis that "fertility is a thing of all degrees." In particular they show: (1) the

¹⁰ Several birds nearly 11 years old from this series are still alive.

¹¹ For four pairs testing absolutely infertile see list near close of Chapter II. The data left by the author do not fully decide this point, but breeding of these hybrids *inter se* by the editor has made it clear that the degree of fertility here shown for pairs 1, 3, 4, 9, and 10 is most unusual in *inter se* crosses.

¹² The limitation of color by sex shown in these matings has already been described.



- A. Parents called guinea-red and guinea-black (common pigeons, see table 70) and two of their much whitened offspring (*J* 1 and *J* 2)—the last of the season of 1909. The black bird is the dam; the sire stands behind her. The two whitened young are to the left.
- B. Adult pouters, male No. 7 and female No. 8 (of table 79), and two of their strongly color-diverging offspring (*E* 1 and *E* 2) from the last clutch of the season (table 80) of 1909. Young photographed Oct. 14, 1909, at about 5½ weeks after hatching. Male No. 7 stands behind the young (*E* 2), whose feathers are white in the basal portions and red-orange distally. In this young no bars are present. Female No. 8 stands in the center between the male and the rock-gray young. The color of the bars of the dam is purer white than in the sire, where white is mixed with red. Juvenal *E* 1 (the bird with general rock-gray plumage) has the bars not white but red-orange.

relation of late season to infertility (tables 57, 59, 60); (2) the wide range of fertility of a male *orientalis* \times *risoria* hybrid (*OS 8*); (3) the association of a plain gray color and "weak germs" in the further breeding of one of the offspring of this male (table 57); (4) the formation of a hybrid composed of 5 species¹³ from 2 genera (pair 25); and (5) the high frequency of abnormally sexed individuals or of hermaphrodites which result from these crosses (pairs 19, 21, 24, 27, 28). In table 62 it will be noted that when a male composed of 4 species was mated to a hybrid female the 2 resulting offspring were both *hermaphrodites*.

Further discussion of these records will not here be attempted, except for one or two points which deal with offspring and descendants of the male *orientalis* \times *risoria* hybrid (*OS 8*) mentioned above. The data for the origin or pedigree of the several kinds of young of this bird are found in the tables (54) under pairs 14 to 18. Two of these young (*OS 8* \times *alba*) were mated together (brother and sister) and produced (table 55) a single bird which at a little more than 3 years of age was abnormally sexed or unsexed. There was no left gonad, and a tubercular growth was present in the region of the right gonad. In pair 20 (table 56) a son of male *OS 8* and of a female *risoria-turtur-alba* seems fully fertile with a female *alba*, but the offspring are not long-lived.

In pair 21, a brother to the male of pair 20 just described was mated with a pure blond-ring female. Here, as with the brother mated to *alba*, there is at first apparently full fertility with the production of young of short life-term. But, with "crowded reproduction" in this cross, there also appears in the late autumn complete infertility, and bordering this period, both before and after, *the production of a plain gray coloration not met with in the season of full fertility and strong germs*. The two aberrantly colored forms were both short-lived and one at least was inadequately sexed, showed a symmetrical deformity of the fourth toe, and had 11 instead of 12 tail feathers. One of the sons from this mating was similarly mated to a pure *risoria*, and reproduced the longevity and fertility features of the cross just described, as may be seen in table 59.

A brother and sister (σ *OS—D 3—D* \times φ *OS—D 3—E*) of this last-named male proved fertile in both eggs of a single clutch (1909). The first gave rise to a female with the lighter color of the dam and lived nearly 6 months; the second young of unknown sex had the color of the sire, and lived probably more than 18 months (disappeared). A sister (*OS—D 3—B*) proved fertile in 1 of 6 tests (first egg of third clutch) with a male *orient.-turt.-alba* hybrid (*OS—D—C*). Still another brother (*OS—D 3—H*) proved fertile (second egg of first clutch) with a female *Streptopelia capicola*. This pentahybrid lived probably half a year. Its composition was $\frac{3}{2}$ *orient.*— $\frac{1}{2}$ *turt.*— $\frac{1}{2}$ *ris.*— $\frac{2}{2}$ *alba*— $\frac{1}{2}$ *capicola*.¹⁴

¹³ Another pentahybrid of different composition is described in the concluding paragraph of this chapter.

¹⁴ "Here the two species of turtle-doves, *T. orientalis* and *T. turtur* = ca. $\frac{1}{6}$

The two ring-doves, *St. risoria* and *St. alba* = ca. $\frac{1}{6}$

The Cape ring-dove = ca. $\frac{1}{6}$

The three species of rings, total = ca. $\frac{1}{6}$

"The turtle-doves will be practically swamped and the result would be not much more than a simple cross between *St. risoria* and *St. capicola*. That is about what the immature pentahybrid appears to be. Possibly if it matures it may give some hints of other ancestry in its voice, color of eye, etc." (F 11)

TABLE 37.

<i>♂ T. orientalis</i> (35); 8/13/04; alive 1917; 12½+ yr.	
<i>♀ St. alba</i> (67); died summer of 1906.	
A 1. 5/30/06; no development.	1.....S/18/10.....4 yr. 2 mo. 17 da.
A 2. 6/1/06.....	
<i>♂ T. orientalis</i> (35); (same as above); 12½+ yr.	
<i>♀ St. alba</i> (87); 5/8/09; probably 3 to 5 yr.	
A 1. 3/2/07; no development.	
A 2. 3/4/07; no development.	
<i>♂ B 1. 3/25.....</i> 2.....alive 2/1/17.....10+ yr.	
<i>♀ B 2. 3/27.....</i> 3.....alive 2/1/17.....10+ yr.	
<i>♂ C 1. 5/3.....</i> 4.....6/14/12.....5 yr. 1 mo. 11 da.	
<i>♀ C 2. 5/5.....</i> 5.....alive 2/1/17.....9½+ yr.	
<i>♀ D. 6/27.....</i> 6.....alive 2/1/17.....9½+ yr.	
E 1. 7/19.....7.....disappeared 2/1/11-11/1/12.....4 to 5 yr.	
♀ E 2. 7/21.....8 (very dark).....disappeared 11/28/11.....4 yr. 4 mo. 7 da.	
F 1. 8/27.....(killed by lice).....2 da.	
F 2. 8/29.....(killed by lice).....2 da.	
<i>♂ G. 10/15.....</i> 9.....alive 2/1/17.....9½+ yr.	
<i>♂ H 1. 2/24/08.....</i> 10.....dead 10/15/16.....8 yr. 7 mo. 21 da.	
H 2. 2/26/08.....	
11. 3/22.....11.....4/10/08 (food ?).....18 da.	
12. 3/24.....12.....4/11/08 (food ?).....18 da.	
K 1. 4/23; developed to time of hatching (exposure ?).	L 1. 5/21; not tested.
K 2. 4/25; developed to time of hatching (exposure ?).	L 2. 5/23; not tested.
<i>♀ M 1. 6/22.....</i> 13.....dead 12/8/15.....7 yr. 5 mo. 16 da.	
<i>♀ M 2. 6/24.....</i> 14.....6/26/11.....3 yr. 2 da.	
<i>♂ N 1. 7/30.....</i> 15.....alive 2/1/17.....8½+ yr. (see pl. 10)	
<i>♂ N 2. 8/1.....</i> 16.....dead 4/12/16.....7 yr. 8 mo. 11 da.	
<i>♂ O 1. 9/9.....</i> 17.....12/23/09.....1 yr. 3 mo. 14 da.	
<i>♀ O 2. 9/11.....</i> 18.....alive 2/1/17.....8½+ yr.	
<i>♀ P. 1/10/09.....</i> 19.....alive 2/1/17.....8+ yr.	
<i>♂ Q 1. 3/5.....</i> 20.....alive 2/1/17.....8+ yr.	
<i>♀ Q 2. 3/7.....</i> 21.....alive 2/1/17.....8+ yr.	
<i>♀ R 1. 4/10.....</i> 22.....(? alive 2/1/17).....8+ yr.	
R 2. 4/12.....23.....dead 5/4/09 (wry neck).....22 da.	

TABLE 38.

<i>♂ T. orientalis</i> (35); 8/13/04; alive 2/1/17; 12½+ yr.	
<i>♀ St. alba</i> (8); 1907; 4/17/13; 6 yr.	
S 1. 5/16/09.....	24.....died early, neglected.
S 2. 5/18.....	25.....died early, neglected.
T 1. 6/14.....	26.....died before 2/1/11.
♀ T 2. 6/16.....	27.....alive 2/1/17.....7½+ yr. (see pl. 11)
<i>♂ U 1. 8/7.....</i> 28.....accident, 12/19/09.....4 mo.	
<i>♀ U 2. 8/9.....</i> 29.....9/17/09.....1 mo. 8 da.	
<i>♀ V 1. 4/2. 10.....</i> 30.....alive 2/1/17.....7+ yr.	
<i>♀ V 2. 4/4. 10.....</i> 31.....alive 2/1/17.....7+ yr.	
<i>♀ W 1. 5/25.....</i> 32.....alive 2/1/17.....6½+ yr.	
<i>♀ W 2. 5/27.....</i> 33.....alive 2/1/17.....6½+ yr.	
<i>♂ X. 7/15.....</i> 34.....alive 2/1/17.....6½+ yr.	
Y 1. 8/18.....	35.....6/9/11.....9 mo. 21 da.
♀ Y 2. 8/20.....	36.....alive 2/1/17.....6½+ yr.
<i>♂ Z 1. 10/1.....</i> 37.....alive 2/1/17.....6½+ yr.	
<i>♀ Z 2. 10/3.....</i> 38.....2/5/11.....4 mo. 2 da. (F 2)	

Breeding continued by O. R.

<i>♀ [A 1. 4/20/11] one killed hatching; other=427 ♀</i>	<i>alive 2/1/17.....</i> 6+ yr.
<i>♀ [A 2. 4/22/11]</i>	
? <i>♂ [B 1. 5/22] (B 2. 5/24) one broken; other=474? ♂</i>	<i>alive 2/1/17.....</i> 6+ yr.
<i>♂ F 1. 8/14.....</i> 457.....alive 2/1/17.....5½+ yr.	
<i>♂ F 2. 8/16.....</i> 478.....escaped late 1914.....3+ yr.	
<i>♂ G 1. 8/23.....</i> 402.....alive 2/1/17.....5½+ yr.	
G 2. 8/25; 7 day embryo; 7 da.	

? *♀ K. 10/24; hatched; died at about 2 weeks; 28 da.*

(O. R.)

1 The clutches not accounted for here were not incubated, but used in other studies.—EDITOR.

TABLE 39.

σ^3 *T. orientalis* (35) (continued); alive; $12\frac{1}{2}$ + yr.
 φ *St. alba* (8) (continued).

A 1. 3/22/12; dark; deserted eggs.	D. 4/19; dark; disappeared early.
A 2. 3/24/12; dark; deserted eggs.	
B 1. 4/1; analysis.	E. 4/29; analysis.
B 2. 4/3; analysis; broken.	
C 1. 4/11; analysis.	F 1. 5/23; analysis.
C 2. 4/13; analysis.	F 2. 5/25; analysis.
φ G 1. 6/1.....dark.....893.....	alive 2/1/17.....56+ mo.
σ^3 G 2. 6/3.....dark.....830.....	alive 2/1/17.....56+ mo.
σ^3 H 1. 6/9.....dark.....863.....	alive 2/1/17.....56+ mo.
σ^3 H 2. 6/11.....dark.....881.....	alive 2/1/17.....56+ mo.
σ^3 I 1. 6/28.....dark.....858.....	died 1/15/14.....18 mo. 18 da.
σ^3 I 2. 6/30.....dark.....894.....	alive 2/1/17.....55+ mo.
J 1. 7/6; analysis.	
J 2. 7/8; analysis.	
φ K 1. 7/26.....dark.....890.....	alive 2/1/17.....54+ mo.
K 2. 7/28; analysis.	
? σ^3 L. 8/3.....dark.....875.....	alive 2/1/17.....54+ mo.
? φ M 1. 8/25.....dark.....870.....	alive 2/1/17.....53+ mo.
? σ^3 M 2. 8/27.....dark.....824.....	alive 2/1/17.....53+ mo.
? φ N. 9/3.....dark.....810.....	alive 2/1/17.....53+ mo.
O. 9/25; analysis.	
? φ P 1. 10/7.....dark.....812.....	alive 2/1/17.....52+ mo.
P 2. 10/8; broken; laid prematurely.	(O. R.)

TABLE 40.

φ *St. alba* till 4/17.
 σ^3 *T. orientalis* (35) (cont., 4/17 till 9/20/13); alive, $12\frac{1}{2}$ + yr.
 φ *St. alba* (649); (purity?); died 10/1/13.

φ 649 from dealer January 31, 1913; was then a young bird 4 to 8 mo. σ^3 35 given April 17, 1913. No. 649 female mated with another *St. alba* male till April 17, 1913.

A 1. 3/21/13; not tested.	σ^3 D 1. 5/21/13.....dark.....781.....alive 2/1/17.
A 2. 3/23/13; not tested.	D 2. 5/23/13; broken.
B 1. 4/1; not tested.	φ E 1. 5/29.....dark.....763.....alive. 2/1/17.
B 2. 4/3; not tested.	φ E 2. 5/31.....dark.....725.....alive 2/1/17.
C 1. 4/10; fertile; broken? 3 day embryo.	φ F 1. 6/6.....dark.....728.....alive 2/1/17.
C 2. 4/12; not tested.	σ^3 F 2. 6/8.....dark.....798.....alive 2/1/17.
φ G 1. 6/14.....dark.....797.....	dead 1/5/14.....7 mo.
σ^3 G 2. 6/16.....dark.....717.....	dead 12/10/13.....6 mo.
σ^3 and ?(H 1. 6/22.....dark.....754.....	{one, a σ^3 , alive 4/1/15.....21+ mo.
|H 2. 6/24.....dark.....782.....	{other stolen 8/13/13.
σ^3 I 1. 6/30.....dark.....721.....	alive 2/1/17.....43+ mo.
? I 2. 7/2.....dark.....758.....	alive 2/1/17.....43+ mo.
σ^3 J 1. 7/10.....dark.....796.....	alive 2/1/17.....43+ mo.
J 2. 7/12; slightly broken; 8 day embryo.	
K. 7/21; not tested.	

? *St. alba* (772); given 1 6/16/14 (origin uncertain; probably not pure *alba*).

? J 1. 8/2/14.....dark.....61.....	alive 2/1/17.....30+ mo.
? J 2. 8/4/14.....dark.....81.....	alive 2/1/17.....30+ mo.
K 1. 8/16; no development. ²	
? K 2. 8/18.....dark.....113 (crippled),	dead 10/18/14.....2 mo. (had no sex-glands). ² (O. R.)

¹ From October 1, 1913, to June 16, 1914, this male (35) was kept with a *St. alba* thought to be a female, but which proved to be a male. After June 16, 1914, male No. 35 was given *St. alba* No. 772, which had already produced 18 eggs during 1914. One of 4 eggs since laid proved infertile with this male and one that hatched gave a weak, crippled (leg) bird, dead at 2 months, with no visible trace of a gonad!

² Female 772, the mother of these young, dead of tuberculosis November 23, 1914.

³ None of the tested earlier eggs of this female were wholly infertile, though 1 formed only an 8-day embryo, 1 died while hatching, and 2 were aided in breaking the shell.

TABLE 4L.

σ^3 T. orientalis (35) (cont.); alive 2/1/17; 12½+ yr.

♀ 1. alba. ¹ risoria (nearly) (561); 4/23/14; alive ¹ 2/1, 17; 3+ yr.

A. 1'26-15; first egg in life, not tested.

B 1. 3; 17; lost. B 2. 3; 19; lost.	C 1. 3; 26; infertile. C 2. 3/28; infertile.	H 1. 5/10; no trace of development. H 2. 5/12; lost.
♂D 1. 4/5; hatched; dark; A 75; alive 2/1/17. D 2. 4/7; disappeared.		I 1. 5/18; broken. I 2. 5/20; broken.
E 1. 4/14; broken; 8 day dead embryo. E 2. 4/16; broken; about 3 day embryo.		J 1. 5/26; no trace of development. ♂J 2. 5/28; hatched; dark; 954; alive 2/1/17.
♀F 1. 4/23; hatched; dark; 177; alive 2/1/17. F 2. 4/25; imperfect shell; broken.		♀K 1. 6/3; dark; 919; alive 2/1/17. K 2. 6/5; no trace of development.
♀G 1. 5/1; hatched dark; dead (cold ?) 5/17/15. G 2. 5/3; thin shell.		L 1. 6/11; no trace of development. L 2. 6/13; no trace of development. (O. R.)

¹ This dam is from an "overworked" series, and may not be of full normal strength.

TABLE 42.

St. alba (O); 1904 (?); 10/10/06; 2½ yr.(?).

T. orientalis (54); 8/19/05; 11/?/09-12/?/10; 5 yr. (?).

A 1: 5/2/06; pipped, failed to hatch.

A 2. 5/6(?)/06; no development.

?♂ B 1. 6/13.	dark	1.	8/8/06 (care ?)	1 mo. 23 da.
?♂ B 2. 6/15	dark		7/2/06 (care ?)	17 da.
?♂ C 1. 7/21.	dark	2.	12/10/07	1 yr. 4 mo. 19 da.
?♂ C 2. 7/23	dark	3.	between 1/1/09-2/1/11	?3 yr.

St. alba ?/?-04 (dealer); 5, 17/09; probably 5 yr.

T. orientalis (54) (cont.)

♂ A.	1/24/07	dark	4	alive 8/1/14	7½ yr.
B.	3/1;	no development.			
♀ C 1.	3/24	white	5	3/18/14	6 yr. 11 mo. 15 da.
C 2.	3/26	no development.			
D 1.	4/27	no development.			
♂ D 2.	4/29	dark	6	3/18/12	4 yr. 10 mo. 19 da.
♂ E 1.	6/2	dark	7	8/4/13	6 yr. 2 mo. 2 da.
♂ E 2.	6/4	dark	8	alive 8/1/14	7+ yr.
♀ F 1.	7/14	white	9	alive 8/1/14	7+ yr.
♀ F 2.	7/16	white	10	4/26/13	5 yr. 9 mo. 10 da.
♂ G 1.	8/25	dark	11	alive 8/1/14	7+ yr.
♀ G 2.	8/27	white	12	alive 8/1/14	7+ yr.
♂ H 1.	12/12/08	dark	13	escaped 11/26/13	6+ yr.
♀ H 2.	2/14/08	white		4/26/10	2 yr. 2 mo. 12 da.
♂ I 1.	3/18	dark	15	10/13/12	4 yr. 7 mo.
♂ I 2.	3/20	dark	16	alive 8/1/14	6½ yr.
♀ J 1.	4/17	white	17	killed 10/2/13	½ yr.
♀ J 2.	4/19	white	18	alive 8/1/14	6+ yr.
♀ K 1.	5/23	white	19	1/15/10	1 yr. 7 mo. 17 da.
♀ K 2.	5/25	white	20	(lice) 6/23/08	
♀ L 1.	6/26	white	21	killed 4/9/14	6+ yr.
♀ L 2.	6/28	white	22	killed 10/2/13	5+ yr.
♀ M 1.	8/9	white	23	escaped 11/13/13	5+ yr.
♀ M 2.	8/11	white	24	alive 8/1/14	6+ yr.
♀ N 1.	9/20	white	25	alive 8/1/14	6+ yr.
♀ N 2.	9/22	white	26	developed, not able to break through shell.	

No other eggs during season!

(F 2)

TABLE 43.

♂ St. alba (410) ($\frac{3}{4}$ alba- $\frac{1}{4}$ risoria); May or June 1911; dead 11/24/13; 29 mo.	
♀ T. orientalis (500); 6/11/11; alive 2/1/17; 68+ mo.	
♂ B. 6/7/12.....dark.....805.....alive 2/1/17.....	56+ mo. ¹
♂ C 1. 6/15.....dark.....811.....alive 2/1/17.....	56+ mo.
♀ C 2. 6/17.....white.....823.....alive 2/1/17.....	56+ mo. (a very large egg).
D 1. 6/24; no development.	
♂ D 2. 6/26.....dark.....842.....alive 2/1/17.....	55+ mo.
♂ F 1. 7/15.....dark.....809.....escaped or disappeared about 1/14.	
♂ F 2. 7/17.....dark.....847.....alive 2/1/17.....	55+ mo.
♂ H 1. 8/2.....dark.....821.....alive 2/1/17.....	54+ mo.
♂ H 2. 8/4.....dark.....888.....alive 2/1/17.....	54+ mo.
I 1. 8/13; no development.	
♂ I 2. 8/15.....dark.....804.....stolen 7/4/13.	
J 1. 8/23; no development.	
♀ J 2. 8/25.....white.....833.....alive 2/1/17.....	53+ mo.
♀ K 1. 9/15.....white.....806.....alive 2/1/17.....	53+ mo.
♀ K 2. 9/17.....white.....900.....alive 2/1/17.....	53+ mo.
♂ C 1. 5/25/13.....dark.....716.....alive 2/1/17.....	44+ mo.
♂ C 2. 5/27/13.....dark.....753.....alive 2/1/17.....	44+ mo.
♂ E 1. 6/10.....dark.....774.....alive 2/1/17.....	44+ mo.
E 2. 6/12; no development.	
♂ F 1. 6/19.....dark.....723.....alive 2/1/17.....	44+ mo.
♀ F 2. 6/21.....white.....770.....disappeared early.	
♂ G 1. 6/26.....dark.....712.....alive 2/1/17.....	43+ mo.
G 2. 6/28; broken.	
♂ H 1. 7/4.....dark.....743.....alive 2/1/17.....	43+ mo.
♀ H 2. 7/6.....white.....791.....dead 10/12/16.....	39 mo. 6 da.
♂ I 1. 7/12.....dark.....773.....dead 10/15/16.....	39 mo. 3 da.
♀ I 2. 7/14.....white.....789.....died hatching ²	0 da.
?♂ L 1. 8/9.....dark.....died hatching.....	
L 2. 8/11; broken.	
♂ M 1. 8/19.....dark.....746.....alive 2/1/17.....	42+ mo.
♂ M 2. 8/21.....dark.....778.....alive 2/1/17.....	42+ mo.
♂ N 1. 8/30.....dark.....709.....alive 2/1/17.....	41+ mo.
♀ N 2. 9/1.....white.....780.....alive 2/1/17.....	41+ mo.

¹ The clutches (eggs) not accounted for here were used in other studies.² Note that the parents "rested" (26 days) before producing the next pair of eggs.

(O. R.)

TABLE 44.

♂ St. alba (767); (nearly pure); 6/23/13; dead 9/27/15; 27 mo.	
♀ T. orientalis (500); 6/11/11; alive 2/1/17; 68+ mo.	
♀ A 1. 5/1/14.....white.....572.....alive 4/1/15.	♂ B 1. 5/11.....dark.....501.....alive 4/1/15.
♀ A 2. 5/3/14.....white.....582.....alive 4/1/15.	♂ B 2. 5/13.....dark.....522.....alive 4/1/15.
♂ C 1. 5/19.....dark.....544.....dead 10/5/14.	
♂ C 2. 5/21.....dark.....fully developed embryo.	D. 5/31?; broken egg.
♂ E 1. 6/5.....dark.....581.....dead (starved) 7/18/14.	
?♀ E 2. 6/7.....white.....dead (not well fed) 6/27/14.	
♀ F 1. 6/14.....white.....48.....alive 4/1/15.	
?♂ F 2. 6/16.....dark.....46.....alive 4/1/15.	
♂ G 1. 6/22.....dark.....killed by lice 7/15/14.	♀ H 1. 7/2.....white.....32.....alive 4/1/15.
G 2. 6/24; laid from perch, broken.	♀ H 2. 7/4.....dark.....43.....alive 4/1/15.
♀ I 1. 7/11.....white.....21.....a nearly pure; albino; dead 8/21/14.	
♀ I 2. 7/13.....white, a weak bird, not fed, died 7/28/14.	
?♂ J. 7/20.....dark.....58.....alive 4/1/15.	♂ N 1. 8/31.....dark.....118.....alive 4/1/15.
♀ K 1. 7/28.....white.....94.....alive 4/1/15.	N 2. 9/2; broken.
♀ K 2. 7/30.....white.....82.....alive 4/1/15.	♂ O 1. 9/21.....dark.....166.....alive 4/1/15.
L 1. 8/7; infertile.	♂ O 2. 9/23.....dark.....full term embryo, dead.
♂ L 2. 8/9.....dark.....111.....alive 4/1/15.	?♂ P 1. 10/3.....dark.....164.....alive 4/1/15.
M 1. 8/22; infertile.	?♂ P 2. 10/5.....dark.....136.....alive 4/1/15.
?♂ M 2. 8/24.....dark (embryo); egg broken.	?♀ Q 1. 10/28.....white.....171.....alive 4/1/15.
?♂ R 1. 11/29.....dark.....killed by fall at few days old ¹ .	?♀ Q 2. 10/30.....white.....173.....alive 4/1/15.
?♂ R 2. 12/1-?.....dark ?.....thrown or fell from nest (to radiator) at time of hatching.	
?♂ S 1. 12/14.....dark.....131.....alive 4/1/15.	
♀ S 2. 12/16.....white.....pure albino dead 1/2/15; lower jaw 1 mm. too long; two plain ovaries.	
?♂ T 1. 12/26.....dark.....killed (by rats) 1/25/15.	
?♂ T 2. 12/28.....dark.....killed (by rats) 1/27/15.	

(O. R.)

¹ Note that a "rest" of 29 days preceded this pair of eggs.

TABLE 45.—On the "shifting of dominance" of sex in crosses of *alba* × *orientalis*.

No. of female parent.	Year.	Before July 1.		After July 1.		Total.		See table:
		♂	♀	♂	♀	♂	♀	
54	1906	2	0	2	0	4	0	42
	1907	4	1	1	3	5	4	42
	1908	3	1	0	10	3	11	42
	1909	1	1	...	...	1	1	42
99	1912	3	1	2	6	5	7	23
	1913	1	0	1	0	2	0	24
500	1912	3	1	5	3	8	4	43
	1913	5	1	6	3	11	4	43
	1914	7	4	14	8	21	12	44
Total . . .	...	29	10	31	33	60	43	...

TABLE 46.—On the relations between "width of cross" and the sex ratio in *T. orientalis*.

Mating.	Width of cross.	No. males.	No. females.	Ratio.
Columba × <i>orientalis</i>	Families	15	1 (or 2)	15.00 : 1 or 7.50 : 1
Alba × <i>orientalis</i> (spring)	Genera	29	10	2.90 : 1
Alba × <i>orientalis</i> (average)	Do	60	43	1.40 : 1
Orientalis × alba	Do	37	37	1.00 : 1
Average reciprocal crosses	Do . . . . .	...	...	1.20 : 1
Orientalis × turtur	Species	7	4	1.75 : 1
Turtur × <i>orientalis</i>	Do	7	14	0.50 : 1
Average reciprocal crosses	Do . . . . .	...	...	1.12 : 1
Unrelated orientalis	Same species	33	29	1.14 : 1
Related orientalis	Same species (-)	21	25	0.84 : 1

TABLE 47.

♂ St risoria (1); (1900); 5+ yrs.

♀ T. orientalis (13); 5/28/03; 3/4/06; 2 yrs. 9 mo. 24 da.

A 1. 4/16/04; no development.				
A 2. 4/18/04; no development.				
♂ B 1. 4/23.....	1.....	alive 2/1/17.....		153+ mo. (see pl. 12).
B 2. 4/25; (?) no development.				
♀ C 1. 5/3.....	2.....	1/13/09.....		56 mo. 10 da.
♀ C 2. 5/5.....	3.....	disappeared 2/1/11-11/4/13.....		82 to 114 mo.
D 1. 6/2; not hatched.				
♂ D 2. 6/4.....	4.....	dead 10/12/16.....		148 mo. 16 da.
E 1. 6/25; deserted.				
E 2. 6/27; deserted.				
♂ F 1. 7/12.....	dark.....	5.....	9/22/04.....	2 mo. 10 da.
♀ F 2. 7/14.....	light.....	6.....	12/8/08.....	53 mo. 24 da.
G 1. 8/15?; not hatched.				
G 2. 8/17?; not hatched.				
H 1. 8/28; not hatched.				
♀ H 2. 8/30.....	dark.....	7.....	disappeared 4/8/06-2/1/11.....	20 to 78 mo.
I 1. 9/12; deserted.				
I 2. 9/14; deserted.				
♂ J 1. 10/23.....	dark.....	8.....	killed (weak) 4/28/07.....	30 mo. 5 da. +
J 2. 10/25; not hatched.				
K 1. 11/10; deserted.				
K 2. 11/12; deserted.				

TABLE 47 (*continued*).

♂ L 1. 3/6/05.....	dark.....	9.....	2/5/11.....	71 mo.
♂ L 2. 3/8/05.....	dark.....	10.....	3/23/09.....	48 mo. 15 da.
M 1. 4/8; deserted.			N 1. 4/19; deserted.	
M 2. 4/10; deserted.			N 2. 4/21; deserted.	
O 1. 4/28.....	dark.....		5/23/05.....	25 da.
♀ O 2. 4/30.....	light.....	11.....	stolen 8/13/13.....	100+ mo.
♂ P 1. 5/28.....	dark.....	12.....	2/5/08.....	32 mo. 7 da.
♂ P 2. 5/30.....	dark.....	13.....	alive 2/1/17.....	140+ mo.
Q 1. 6/27; deserted.				
Q 2. 6/29; deserted.				
♀ R 1. 7/4.....	light.....	14.....	9/28/08.....	38 mo. 24 da
R 2. 7/6; no development.				
S 1. 8/5; broken.			T 1. 9/11; fertile, but deserted.	
♀ S 2. 8/7.....	dark ¹	15; dead 5/14/16.....	T 2. 9/13.....	(F 13)

¹ Apparently hermaphrodite, certainly abnormal; two flat minute gonads (4 and 5 mg.); acted as a male and fought till end for mates.—EDITOR.

TABLE 48.

♂ T. orientalis (14); 7/6/03; 6/3/09; 5 yr. 10 mo. 27 da.				
♀ St. risoria (1903); 11/10/04; 1+ yr.				
♂ A 1. 5/8/04.....	dark.....	1.....	stolen 7/19/12.....	98+ mo. (see pl. 13).
♀ A 2. 5/10/04.....	slightly lighter.....	2.....	dead 2/4/13.....	106 mo. 4 da.
♀ B 1. 5/29.....		3.....	alive 2/1/17.....	152+ mo.
♀ B 2. 5/31.....	dark ¹	4.....	dead 1/18/12.....	91 mo. 18 da.
♂ C 1. 7/9.....	dark.....	5.....	alive 2/1/17.....	151+ mo.
♂ C 2. 7/11.....	dark.....	6.....	dead 10/18/08.....	51 mo. 7 da.
♀ D 1. 8/15.....	dark.....	7.....	dead 9/9/14.....	120 mo. 24 da.
♂ D 2. 8/17.....	dark.....	8.....	dead 5/30/15.....	129 mo. 13 da.

♂ T. orientalis (0); "old bird" when mated.

♀ St. risoria (0); age unknown.

A 1. 3/26/05.....	dark golden.....	9.....	3/30/07.....	24 mo. 4 da.
A 2. 3/28/05.....	dark golden.....	10.....	probably died young.	
B 1. 5/5; deserted.			C 1. 5/22; dead at 1 day, neglect.	
B 2. 5/7; deserted.			C 2. 5/24; failed to hatch.	
♀ D 1. 6/15.....	dark.....	11.....	4/13/07.....	21 mo. 28 da.
♀ D 2. 6/17.....	dark.....	12.....	1/1/09.....	41 mo. 15 da.

(F 13)

¹ Probably no attempt was made to distinguish shades of color in birds from this and succeeding clutches.—EDITOR.

TABLE 49.

Pair 1.

♂ St. alba (1); age unknown.

♀ alba × orient. (28); white; 3/4/09; alive 10/1/14; 5½+ yr.

A 1. 7/17/10; A-AO 1; white; dead 1/5/11.
A 2. 7/19/10; developed a sinus terminalis, and halted.

B 1. 8/12/10; not quite able to hatch,² to be white.
B 2. 8/14/10; "made no development."

(F 5)

Pair 2.

♂ St. alba; age unknown.

♀ alba × orient. (23); white; 8/9/08; escaped 11/13/13; 5+ yr.

A 1. 7/29/10; no development.
A 2. 7/31/10; developed, a small blood circle.

B 1. 8/16; developed, but failed to hatch.
B 2. 8/18; no development.

C 1. 9/18; A-AO 1; white; weak; died in about 24 hours.
C 2. 9/20; developed about 7 day embryo.

(F 5)

² "This a white bird that evidently failed to hatch for lack of strength to perform the last step in its course to hatching. Weakness at end of race."

TABLE 50.

Pair 3.

σ^3 St. risoria (32) (light); age unknown.
 φ alba \times orient. (12) (white); 8/27/07; alive 10/1/14; 7+ yr.

A 1. 7/1/10 } one hatched; white (R-AO 1); disappeared between 7/1/11 and 11/4/13. No record of other egg.
A 2. 7/3/10 }

σ^3 B 1. 8/10; hatched; blond-like; (R-AO 4); alive 10/1/14 = σ^3 or $\sigma^3 \varphi$ (acts like a σ^3 , and infertile).
?B 2. 8/12; hatched; white; (R-AO 5); dead 1/22/11 (no gonad found).

? φ C 1. ¹ 10/24; R-AO 6; white-shaded; bulging occiput; dead (cold) 11/8/10.
C 2. 10/26; developed, but unhatched.

(F 5)

Pair 4.

σ^3 St. risoria (92); age unknown.
 φ St. alba \times orient. (9) (white); 7/14/07; alive 8/1/14; 7+ yr.

?A. 7/30/10; R-AO 2; light blond; dead 8/26/10.

"I noticed Aug. 23 that this bird (R-AO 2) had an *excessively large occiput*; this part of head bulging as if swollen. Aug. 25, I found the bird with a *twisted neck*, held so that the top of the head rested on bed of nest, the beak pointing upward. The bird could not right itself and apparently had failed to get any food. I held its beak to the mouth of the male parent until it was fairly well fed. I doubt if the bird recovers its normal condition. Aug. 26 found this bird dead in the nest, the male parent standing over it, as if waiting to feed it. Death probably due to something going wrong in development; the twisted neck was a sign of this. Sex = ? φ . (Could find no organs for certain)." (F 5)

Pair 5.

σ^3 St. risoria; age unknown.
 φ alba \times orient. (17); white; 4/17/08; killed 10/2/13; 5½+ yr.

A. 8/7/10; R-AO 3; blond; disappeared 7/1/11-11/4/13; "Upper mandible 1 mm. too short; later became right." (F 5)

¹ "Could not be sure of an ovary here."

TABLE 51.

Pair 6.

σ^3 T. orientalis (0); imp. from Japan between 1903 and 1905.
 φ risoria \times orient. hyb. (2); 5/3/04; 1/13/09.

A 1. 4/23/06; pricked shell, deserted, dead without hatching.
A 2. 4/25/06; no development.

? σ^3 B 1. 5/5; hatched; no plain sex-organs; bulging occiput; ¹ dead 10/27/09.
B 2. 5/7; probably no development.

C 1. 6/10; no development.
C 2. 6/12; no development.

D 1. 6/23; not well tested.
D 2. 6/25; not well tested.

E 1. 7/9 } one developed part way, failed; other no development.
E 2. 7/11 }

σ^3 (0) removed 7/28/06.

Pair 7.

σ^3 T. orientalis (66); 6/6/06; given 4/16/07.
 φ risoria \times orient. hyb. (2); same as above.²

A 1. 4/29/07; probably no development.
A 2. 5/1/07; probably no development.

B 1. 5/29; hatched; dead 7/23/08; 5½ wks.
B 2. 5, 31; no development.

C 1. 6/28; no development.
C 2. 6/30; no development.

D 1. 7/?; some development.
D 2. 7/?; no development.

(F 14)

¹ "This bird has no plain sexual organs—just a trace (perhaps) of one testicle. It had behaved as a very pugnacious male trying hard to win a mate. Mated with a ring but no result, except he played his part perfectly in sitting, etc.; color intermediate, nearer *T. orient.* than *orient.* \times *risoria* or *risoria* \times *orient.* hybrids. It seemed a well-formed bird except that the head was noticeably enlarged at the occiput."

² Had laid 6 eggs before mating with male 66.

TABLE 52.

Pair 8.

σ^1 Orientalis-alba hyb. (2); 3/25/07; alive 8/1/14; 7+ yr.
 φ St. risoria (29); age unknown.

A 1. 4/14/08; no development.	C 1. 6/21; no development.
A 2. 4/16/08; no development.	C 2. 6/23; no development.
♀ B 1. 5/21; hatched; alive 10/1/14; 6½ yr.	D. 7/25; probably no development.
B 2. 5/23; no development.	

(F 10)

Pair 9.

σ^1 Risoria-orient. hyb. (9); dark; 3/6/05; 2/5/11; 71 mo.
 φ St. risoria (81).

σ^1 A. 5/27/10.....SO-R 1.....rich ruddy risoria.....	dead 5/26/13.....36 mo.
B 1. 7/4.....SO-R 2.....brownish gray; down darker; disappeared between 2/5/11-11/4/13.....	8 to 38 mo.
σ^1 B 2. 7/6.....SO-R 3.....brownish gray; down lighter; dead 3/4/12.....	20 mo

(F 5)

Pair 10.

σ^1 Risoria-orient. hyb. (9); same as above; 71 mo.
 φ Risoria-alba \times douraca (4); white; 6/29/08; 11/10/10; 16½ mo.

A 1. 8/31/10.....SO-RD 1.....interm. risoria-orient.; no later record.....	?
♀ A 2. 9/2/10.....SO-RD 2.....lighter, like risoria; dead 12/30/10.....	3 mo.
B 1. 10/14.....SO-RD 3.....like sire; disappeared 2/5/11-11/4/13.....	16 to 36 mo.
B 2. 10/16.....SO-RD 4.....complexion dark; thrown from nest killed at 1 da.....	(F 3)

Pair 11.

σ^1 Orient. \times risoria (5); 7/9/04; alive 6/1/14; 10+ yr.
 φ Risoria \times orientalis (2); 5/3/04; 1/13/09; 56 mo.

?F 1 or 2. 8/2/05; pricked shell, failed; 10 to 12 other tests showed no development.

A 2. 4/10/06; began development.

(F 18)

TABLE 53.—Other fertility tests of orientalis hybrids crossed with risoria and its hybrids.

Pair 12.

σ^1 (H 1) Domestica \times orientalis hyb.; (1898); 11/15/07; 9 yr.
 φ (M 1) Risoria-alba \times homer hyb.; (4/27/98).

These birds mate, build nests, copulate, etc., month after month, (1899) but no eggs. Same σ^1 with φ common pigeon, 2 to 4 tests 1900. No development. (Probably M 1 was not a female.—EDITOR). (A 13)

Pair 13.

σ^1 Orientalis-risoria (?)
 φ Risoria-douraca (?)

Such a mating (can not find original data—EDITOR) produced at least 1 offspring. φ OS-RD-2 hatched before Nov. 1910 (probably 1908-9); escaped 8/4/13; 3+ yrs. (O. R.)

TABLE 54.

Pair 14.

σ^1 Orientalis \times risoria hyb. (OS 8); 8/17/04; alive 4/1/15; 11+ yr.
 φ Risoria-alba \times turtur \times alba (D 9); 7/25/04; alive 1907; 3+ yr.

A. 8/31/05; hatched; color nearly φ ris.-orient. hyb. ¹ ; dead 10/2/05; 1+ mo.	
σ^1 B 1. 4/4/06; (OS 8-D 1).....color light.....	dead 11/6/07.....19 mo.
B 2. 4/6/06; developed a little.	
♀ C 1. 5/5.....OS 8-D 2.....light w. dull turtle spots.....	dead 10/7/08.....29 mo.
C 2. 5/7; did not hatch.	
D. 6/15; did not hatch.	
σ^1 E. 7/9.....OS 8-D 3.....color closely that of sire.....	dead 2/1/09.....31 mo.
♀ D 9 probably sick 1907; winter 1907-08 plainly tubercular.	

In 1907 mated with a female white ring (St. alba 1); no result, or record not available.

Pair 15.

In 1908 a female white ring (St. alba 1) was given.

A 1. 2/28/08; no development.	
σ^1 A 2. 3/1/08.....OS-A.....very light blond.....	dead 2/1/11-7/1, 11.....? 36 mo.
σ^1 B 1. 4/2.....OS 8-B r.....dark.....	dead 12/27/09.....21 mo.
σ^1 B 2. 4/4.....OS 8-B 1.....light as OS-A; (thrown from nest), killed 4/20/08.....	8 da.

¹ The results of this cross therefore = $\frac{1}{2}$ orient. + $\frac{1}{2}$ tur. + $\frac{1}{2}$ ris. + $\frac{1}{2}$ alba.

TABLE 54 (*continued*).

C 1. 4/28; probably no development (incubation not perfect).				
C 2. 4/30; probably no development (incubation not perfect).				
♀ D 1. 5/20.....OS 8-D r.....rather ring-like (trace of tur.).....dead 12/10/09.....				19 mo.
♂ D 2. 5/22.....OS 8-D l.....pale blond.....dead 12/3/08.....				6 mo.
♂ E 1. 6/22.....OS 8-E.....darker shade, fertile.....dead 11/19/10.....				29 mo.
♀ E 2. 6/24.....OS 8-E.....lighter shade like risoria.....dead 11/25/09.....				17 mo.
F 1. 7/22; no development.				
F 2. 7/24; no development.				
G 1. 8/29.....OS 8-G r.....dark, but lighter than sire.....dead 12/24/09.....				16 mo.
♀ G 2. 8/31.....OS 8-G l.....lighter, more like risoria.....alive 2/1/11.....				30+ mo.
♂ H 1. 9/18.....OS 8-H r.....light, as lighter risoria.....dead 3/27/09.....				6 mo.
♂ H 2. 9/20.....OS 8-H l.....quite dark ².....dead 12/26/09.....				15 mo.
♂ I. 11/15.....OS 8-I.....an even dark (intermed.).....dead 12/10/08.....				1 mo.
J 1. 12/5; pricked shell and died.				
J 2. 12/7; no development.				(F 4)
K 1. 2/26/09; (chilled); pricked shell (late), was helped out and died 1st day; lighter than K 2.				
K 2. 2/28/09.....OS 8-K.....dark.....dead 3/4/09.....				
L 1. 3/4.....OS 8-L.....dark ³.....one probably dead 1/23/10; other no record.				
L 2. 3/6.....OS 8-L.....dark ³				

♀ alba × orientalis (17) given 1909. Only one egg; no development=pair 16.

Pair 17.

Later a grand-daughter given as mate. This new ♀ (OS-D 3-F) was from OS 8-D 3 above and a ♀ blond ring, and hatched 1908.

- ♂ A 1. 4/20/10; same shade of brown as dark hyb. of orient. × risoria dead 5/4/10; 2 weeks.
 A 2. 4/22/10; no development.

Pair 18.

♀ $\frac{1}{4}$ ris.- $\frac{1}{4}$ alba× $\frac{1}{2}$ douraca hyb. (RD 5) given near end of Aug. 1910.

- ♂ A 1. 9/2/10; color, like risoria; dead 10/10/10.
 ♀ A 2. 9/4/10; color, darker, more like tur.-risoria hyb.; dead 12/30/10.³

²"This pair of young repeat the two colors of the previous pair, but the first egg here produces light instead of dark color, and the second egg here produces dark instead of light." (F 4)

³The data for the bigeneric hybrid OS 8 show it to have been fertile with:

- (a) the trispecific hybrid D 9 (=ris.-tur.-alba).
- (b) the pure St. alba (1).
- (c) the related (granddaughter) tetrahybrid OS 8-D 3-F (= $\frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{2}$ ris.- $\frac{1}{2}$ alba).
- (d) the trispecific hybrid RD 5 (= $\frac{1}{4}$ ris.- $\frac{1}{4}$ alba× $\frac{1}{2}$ douraca).

Lighter and darker shades appear, but in most cases the special colors of the several species entering into the cross is noted.

TABLE 55.

Pair 19.

Two of the above offspring (♂ OS-A and ♀ OS 8-G=brother and sister from OS 8 × a pure alba) were mated 1910, producing the following:

- ?A. 5/15/10.....2 OS-A 1.....roseate blond.....killed 9/10/13.....40+ mo.

This bird had a large tubercular growth in the region of the right¹ gonad, but no gonad discoverable.

The only offspring of this brother-sister mating, in which the parents were trispecific hybrids, was therefore an imperfectly sexed individual.

¹The normal female pigeon has only one gonad—the left; the normal male has two.—EDITOR.

TABLE 56.

Pair 20.

♂ OS 8-D 1(= $\frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{4}$ alba); pale blond; 4/4/06; dead 11/6/07; 19 mo.

♀ St. alba=from ♂ (1) × ♀ (1)

Composition of young= $\frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{2}$ ris.- $\frac{1}{2}$ alba.

- A 1. 5/6/07; OS-D-A 1; color, size, shape as in sire; dead 11/28/07; 7 mo.

- A 2. 5/8/07; complexion of A 1; (poor care ?); dead 5/25/07; 2 da.

- B 1. 6/15; egg lost.

- B 2. 6/17; egg lost.

- ♂ C 1. 7/7; OS-D-C r.....color like sire; (fertile); dead between 2/1/11 and 11/4/13; 4 to 5 years.

- ♀ C 2. 7/9; OS-D-C l.....trace lighter than C 1; dead 11/14/07; 4 mo.

(F 1)

TABLE 57.

Pair 21.

 σ^a OS S-D 3 ($= \frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{4}$ ris.- $\frac{1}{4}$ alba); dark; 7/9/06; dead 2/1/09; 31 mo. φ St. risoria (stray bird, captured, May 1907); isabelline.The young of this pair have the composition: $\frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{4}$ ris.- $\frac{1}{4}$ alba.

σ^a A 1. 5/28/07.....	OS-D 3-A-r.....	ring-like nearly.....	dead before 2/1/11.....	? mo.
σ^a A 2. 5/30/07.....	OS-D 3-A-l.....	darker than A 1, nearer sire; dead 11/7/09.....		29 mo.
σ^b B 1. 7/18.....	OS-D 3-B-r.....	ruddy color of risoria.....	dead 11/5/07.....	31 mo.
? φ B 2. 7/20.....	OS-D 3-B-l.....	strong ruddy of risoria.....	dead 10/23/13 ¹	75 mo.
σ^c C 1. 8/27.....	OS-D 3-C-r.....	reddish ring-dove.....	dead 11/30/07.....	3 mo.
? φ C 2. 8/29.....	OS-D 3-C-l.....	reddish ring-dove.....	dead 11/10/07.....	2½ mo.
σ^d D 1. 2/23/08.....	OS-D 3-D-r.....	dark, toward sire; (fertile).....	dead 12/9/09.....	21½ mo.
? φ D 2. 2/25/08.....	OS-D 3-D-l.....	a ruddy ring-dove.....	dead 12/10/09.....	21½ mo.
σ^e E 1. 4/10.....	OS-D 3-E-r.....	nearly like sire.....	dead 6/15/08.....	2 mo.
? φ E 2. 4/12.....	OS-D 3-E-l.....	ring-like; (fertile).....	dead 11/7/09.....	19 mo.
σ^f F 1. 5/22.....	OS-D 3-F-r.....	inclines to dark.....	dead 10/16/09.....	17 mo.
? φ F 2. 5/24.....	OS-D 3-F-l.....	lighter than F 1; (fertile).....	dead 5/15/10.....	24 mo.
G 1. 7/2; did not develop.				
? φ G 2. 7/4.....	OS-D 3-G-l.....	plain gray like douraca ² (probably died young).		
H 1. 8/3.....	OS-D 3-H-r.....	dark-ring-like } one dead 1/3/11.....		29 mo.
σ^g H 2. 8/5.....	OS-D 3-H-l.....	lighter; (fertile) other 4/29/11.....		33 mo.
1. 9/20; no development.		J 1. 10/24; no development.		
1. 9/22; no development.		J 2. 10/26; no development.		
K 1. 12/30; plain gray, like douraca, dead between 2/27/09 and 2/1/11.....				2 to 25 mo.
? K 2. 1/1/09.....	color nearly like sire.....	dead 2/10/09.....		1½ mo.
σ^h parent dead 2/1/09, "a fine looking bird."				(F 1)

¹ Gonad certainly abnormal; no distinct ovary, but a few scattered ova less than 1 mm. in region where ovary should have been.—EDITOR.² Besides the unusual color and somewhat uncertain sex, this bird shows other abnormalities. "It had only 11 rectrices, and the fourth toe on each foot is bent inward (symmetrical). Bird is a little weaker in size than earlier birds of this season."

TABLE 58.

Pair 22.

 σ^a Orientalis-risoria \times alba (OS S-E); dark; 6/22/08; 11/19/10; 29 mo. φ Orientalis-risoria \times ris-turtur \times alba (OS-D 3-F); light; 5/24/08; 5/15/10; 24 mo.

σ^a A 1. 7/2/09.....	OS-E 1.....	nearly dark as sire ¹	dead 11/25/09.....	5 mo.
σ^a A 2. 7/4/09.....	OS-E 2.....	nearly dark as sire.....	dead 10/21/09.....	4 mo.
¹ Offspring = $\frac{1}{4}$ orientalis- $\frac{1}{4}$ turtur- $\frac{1}{4}$ risoria- $\frac{1}{4}$ alba.				

TABLE 59.

Pair 23.

 σ^a OS-D 3-A ($\frac{1}{4}$ orient.- $\frac{1}{4}$ tur.- $\frac{1}{4}$ ris.- $\frac{1}{4}$ alba); darker than ring; 5/30/07. φ St. risoria; dead 11/7/09; 29 mo.

A 1. 5/7/08.....	OS-D 3-A-A r.....	color dark.....	dead before 2/1/11.....	? mo.
? A 2. 5/9/08.....	OS-D 3-A-A l.....	more ring-like (i.e., lighter); dead 5/13/09.....		12 mo.
B 1. 6/17; complexion dark; killed very young.				
? B 2. 6/19.....	OS-D 3-A-B.....	lighter than B 1.....	dead (live ?) 7/4/08.....	
σ^c C 1. 7/10.....	OS-D 3-A-C r.....	like sire.....	dead 8/26/09.....	13½ mo.
? C 2. 7/12.....	l.....	similar to C 1.....	dead 9/1/09.....	13½ mo.
σ^d D 1. 8/22.....	OS-D 3-A-D r.....	color of sire.....	dead 9/11/09.....	13½ mo.
? D 2. 8/24.....	OS-D 3-A-D l.....	complexion ring-like.....	dead 10/8/08.....	1½ mo.
E 1. 10/18.....	OS-D 3-A-E r.....	color nearly of sire; frozen (?) 1/1/12.....		39 mo.
E 2. 10/20.....	OS-D 3-A-E l.....	a little darker than dam; dead 12/20/09.....		14 mo.
F 1. 12/26; no development.				
F 2. 12/28; no development.				
σ^g G 1. 2/25/09.....	OS-D 3-A-G r.....	color of sire.....	dead 1/24/10.....	11 mo.
? G 2. 2/27/09.....	OS-D 3-A-G l.....		dead 10/23/09.....	8 mo.
? H 1. 5/15.....	OS-D 3-A-H r.....	nearly like sire.....	dead 9/7/09.....	4 mo.
? H 2. 5/17.....	OS-D 3-A-H l.....	lighter than sire.....	dead 9/11/09.....	4 mo.
σ^i I 1. 8/16.....	OS-D 3-I r.....	dark as sire, nearly.....	dead 1/31/10.....	5½ mo.
? I 2. 8/18.....	OS-D 3-I l.....	color of dam.....	dead 2/1/10.....	5½ mo.

TABLE 60.

Pair 24.

 σ^3 Turtur-orient. hyb. (5); 6/6/04; alive 8/1/14; 10+ yr. φ Humilis \times hum.-risoria hyb. (HHR 2); S/17/05; S/20/08; 36 mo.

A 1. 4/15/07; no development.

A 2. 4/17/07; no development.

 σ^3 B 1. 5/7.....TO-HR 1.....like sire or turtur (fertile)....dead 1/15/09 (care).20+ mo.
 σ^3 B 2. 5/9.....TO-HR 2.....like sire or turtur (fertile)....dead 10/9/09.....29 mo.

C 1. 6/15; developed (deserted on train).

C 2. 6/17; developed (deserted on train).

D 1. 7/4.....TO-HR 3.....color ?.....dead at 12 days.

D 2. 7/6.....TO-HR 4.....color ?.....dead at 16 days.

E 1. 8/9 {one began development (unsteady incubation ?).
 φ E 2. 8/11/one.....TO-HR 5.....color ?.....dead 12/5/07.....4 mo.

F 1. 3/21/08/one.....TO-HR 6.....skin and down dark.....dead before 2/5/11.....?

F 2. 3/23/08/one.....TO-HR 7.....skin and down trace less dark; dead before 2/5/11.....?

G 1. 4/2.....TO-HR 8.....complexion about that of F 1 and F 2; dead before 2/5/11.....?

G 2. 4/4; no development.

H 1. 4/20; no development (care ?).

 φ H 2. 4/22.....TO-HR 9.....like sire; toward turtur.....dead 8/13/08.....4 mo.

I 1. 5/10; no development.

 φ I 2. 5/12.....TO-HR 10.....dark (more like dam than previous young); dead (food ?).....4 mo. φ or σ^3 J 1. 7/7.....TO-HR 11.....dark "as usual" (φ hermaph.) ; killed 5/1/12.....46 mo.¹
J 2. 7/9.....developed 12 day embryo (2 day of hatching) upper jaw curved to left. (F 16)

Pair 25.

 σ^3 Turtur-orient. \times hum. \times hum.-risoria hyb. (TO-HR 1); 5/8, 07; 1/15, 09 (care); 20 mo. φ St. alba; age and parents unknown. σ^3 A 1. 6/19/08; color and appearance ² of *humilis*, trace lighter, dead at 25 da.

A 2. 6/21/08; no development.

B 1. 7/4; no development.

B 2. 7/6; no development.

C 1. 8/4; no development.

C 2. 8/6; developed, pricked shell, failed; complexion dark like A 1. (F 19)

¹ This bird had an ovary on the left side, but in addition there seemed to be a right gonad involved in a very large tumor. The bird was killed fighting; had a body unnaturally rounded for a dove. Until opened for autopsy thought to be a male; it had certainly behaved so as to give this impression.—EDITOR.² Young = $\frac{1}{2}$ *turtur*, $\frac{1}{4}$ orient., $\frac{1}{8}$ hum., $\frac{1}{16}$ risoria, $\frac{1}{32}$ alba.

TABLE 61.

Pair 26.

 σ^3 Turtur-orient. \times hum. \times hum.-risoria hyb. (TO-HR 2); dark with red (turtur); 5/9, 07; 10/9/09; 29 mo. φ St. risoria; age and ancestry not given; isabelline. σ^3 A 1. 7/5/08.....TO-HR-R 1.....dark, more like sire.....dead 8/22/10.....25 $\frac{1}{2}$ mo. σ^3 A 2. 7/7/08.....TO-HR-R 2.....dark, more like sire.....dead 7/24/09.....13 mo. φ B 1. 8/15.....TO-HR-R 3.....interm. to parents.....dead 2/24/10.....18 mo. σ^3 B 2. 8/17.....TO-HR-R 4.....dark reddish brown; turtur neck-mark; dead 2/8/09.....6 mo.

Pair 27.

 φ St. risoria (2d female here) given 4/14/09. σ^3 A 1. 4/21/09.....TO-HR-R 5.....complexion dark.....dead (cold ?) 5/29/09.....38 da. σ^3 A 2. 4/23/09.....TO-HR-R 6.....color dark, as most young.....dead 5/23/09.....30 da.B 1. 5/19.....TO-HR-R 7.....dark, toward *humilis* (much as former birds); 8/19/10.....15 mo.

B 2. 5/21; no development.

C 1. 6/16.....TO-HR-R 8.....dark as most others; sex abnormal³; dead 9/15/09.....3 $\frac{1}{2}$ mo.

C 2. 6/18; hatched (color of C 1) with deformed legs; killed 7/8; 1 mo.

 σ^3 D 1. 8/1.....TO-HR-R 9.....dark like most former birds; dead of tuberculosis at 14 mo. σ^3 D 2. 8/3.....TO-HR-R 10.....dark like others.....dead 11/4/09.....3 mo. (F 6)¹ "Sex?; I could find no male or female organs."

TABLE 62.

Pair 28.

σ^3 ♀ orientalis- $\frac{1}{2}$ σ risoria- $\frac{1}{2}$ σ turtur- $\frac{1}{2}$ alba hyb. (H); 8/2/08; 1/3/11.
 ♀ alba \times orientalis hyb. (22); 6/22/08; 10/2/13; (killed).

♀ ♂ A 1. 7/29/10; hatched,¹ killed 4/7/14; (*hermaphrodite*) predominantly ♀.²
 ♀ ♂ A 2. 7/31/10; hatched, killed 4/7/14; (*hermaphrodite*) predominantly ♀.²

(F 5)

¹"Notice that in these final hybrids (*A 1* and *A 2*) we have but four species represented, three of which are pretty evenly balanced, each representing about 1/3. The fourth (*Turtur turtur*), the European turtle-dove, is only 1/32 of the whole. The Oriental turtle and the white ring are each 10/32, while the blond ring is 11/32. The color of these hybrids is about what might be expected if the colors of their ancestors were evenly blended. If we regard the white ring and the blond as two very closely allied species—as practically one species—then our hybrids represent about 2/3 ring and 1/3 Oriental turtle. This is, approximately, what the hybrids actually appear to be." (F 5)

²"The upper mandible in both *A 1* and *A 2* is bent a little to the right, forming a sort of cross-bill. I noticed this on the 2d day, and it has not thus far (8/18) changed much. On 9/16/10 the bills are noted as more strongly crossed than at first; the lower bill now turning to the right." In making the autopsies of these birds, the editor failed to note anything concerning their bills. It seems likely that these were nearly normal. These birds for a long time before being killed were thought to be males, as they certainly contested for mates—fighting so that they continually had all the feathers stripped from their necks, and mostly from their heads. Strangely enough an examination of the record of *A 1* indicates that this bird laid several eggs during 1911, while mated with a *St. risoria* male, and that one of the eggs is noted as showing "some development." During the last two years of its life, however, there is no doubt whatever that it laid no eggs and acted as a male. The birds were healthy when killed. Indeed, they were killed because it was thought they would yield abundant material for testis extract. The autopsies of these birds so far as they relate to sex are given herewith in full:

No. OS-DAO 1 (=A 1) is a probable *hermaphrodite*. Left gland ordinary size of ovary for this bird (=about 0.190 to 0.200 gr.). This contains a medial and posterior part plainly ovarian in nature—*i.e.*, shows numerous small ova and some large clear globules posteriorly. The anterior part is testis-like. But there is also a *right gland*, about one sixth of the size of the left, and of doubtful nature, *i.e.*, testis or ovary.

No. OSDAO 2 (=A 2) is practically same as above. Left gland ordinary size and shape of ovary and showing innumerable small ova all less than 0.5 mm., rather homogeneous in contrast to above. A very small, elongate (8 to 10 mm.) right gonad found. Near center of this are ova of 0.5 to 1.5 mm.; quite resembling structure of left gonad—*i.e.*, seems ovarian.

Both of above birds had behaved like males; *i.e.*, had been very aggressive, and had all their neck feathers pulled out in the contest for mates.

CHAPTER VIII.

GUINEA-PIGEONS CROSSED WITH COMMON PIGEONS.

The results of crossing the male guinea-pigeon (*Columba guinea*)¹ with female homers and domestic doves (and with their hybrids) bring into relief several of the most interesting phenomena of hybridization: (1) the shortened life-term of the hybrid (in some crosses); (2) the lesser compatibility of sperm with the ova of hybrids than with ova from a pure strain; (3) the difference in developmental strength of the germs of individuals of the same strain; (4) the lesser strength of germs produced "out of season" or late in the season; (5) the quantitative nature and basis of fertility; and (6) the power of the sperm of one species to affect the rate of development² of the ova of another species. All of the author's data and observations on these points are given in connection with the several tables. The following textual statements and the summaries are made by the editor.

The detailed histories of two of these matings, each extending over a period of 5 years, are given in full in tables 63, 64, and 65. The two male guinea-pigeons used in the matings are designated *G 1* and *G 2*. It will be observed in the tables just cited that *G 1* was mated to 4 different females, and *G 2* to 6 different females; also that they were mated to birds of similar constitution, and that finally both males were tested with the same individual female.

We shall analyze these data rather more fully than is done in most cases elsewhere in this volume, partly because this treatment may assist the reader not only at this point but at others where a minimum of analysis is given, partly because the data here are very complete and unequivocal, and again because some comparisons of the results of one of the series of crosses with the other series might otherwise be overlooked.

The birds concerned in these crosses are of the same genus (see the preceding note), but are very different and probably rather distantly related species. In accord with this the percentage of "infertile" eggs—*i. e.*, eggs capable of little or no development—is high. But the general level of infertility is probably not equally high in the two series. For male *G 1* this percentage is 56, or 24 of 43 tests.³ For *G 2* this percentage of infertility is 43, or 15 of 35 tests.⁴ In partial explanation of this difference, however, the fact that male *G 1* and consorts produced a total of 56 eggs to only 39 in the other series (overwork) is a matter to be considered. The unequal number of eggs produced during the "out season" would also probably serve to explain still another part of this apparent difference. Nevertheless, male *G 1* shows, in 3 of the 4 matings which are wholly comparable with the 5 matings of male *G 2*, a smaller percentage of eggs capable of beginning development (*G 2* ×

¹"Salvadori (p. 241) states that he feels 'sure that the numerous species of *Columba* ought to be arranged in several subgenera.'" (See pl. 80, Vol. I.)

²"This time (for eggs of homer fertilized by *C. guinea*) is 1½ days shorter than in homers and domestic pigeons, and is again a proof that the male influences the rate or speed of development" (P3). The subject is treated in Chap. XVI.—EDITOR.

³11 eggs with "no record," but probably nearly all of no development, are not included; this makes the figure 55 per cent too low.

⁴Only 2 cases of "no record, probably no development," and eliminating the mating of sire to daughter, not represented in matings of *G 1*.

owl-rock is the exception). Furthermore, those that did begin to develop stopped sooner, producing birds of a shorter term of life ($G\ 1 \times$ homer of 1903 is a possible though not a probable exception). Of the 19 eggs of Series I which showed any capacity for development, only one lived more than 19 days, as compared with 8 individuals from the 20 eggs of the other series which lived more than 7 months. Thus it is here clear that the series of "least fertility" is also the series of "shortest-lived" offspring.

In Series I, moreover, it is evident that when the female is more nearly pure (*C. tabellaria*), not obviously hybrid (owl-rock), that both eggs of the clutch are rarely fertilizable; in none of the 12 clutches did both eggs show development.⁵ In Series II, however, the 11 clutches (one clutch had but 1 egg) which showed development showed it in both eggs of the clutch in 8 cases; 2 of the 3 exceptions are first and last clutches of the season. The two series illustrate the fact that *it is when the developmental power of the germs is most strongly reduced that the breeding evidence becomes clearest for the developmental (as apart from sexual) non-equivalence of the two eggs of the pigeon's clutch.*

When owl-rock hybrids are mated (4 matings) with the males of either series, the percentage of infertility is higher than when *pure⁶ tabellaria or domestica* is used, and at the same time the young that develop from the hybrid unions have a shorter term of life than have the young from females of pure strain.

⁵ G 1. \times owl-rock; 6 young lived—3, 7 days; 1, 5 days; 1, 8 days; 1, 10 days; average, 7 days.

⁵ G 2. \times owl-rock; 4 young lived—3, 7 days; 1, 10 days; average, 8 days.

⁵ G 1. \times homer; 8 young lived—2, 1 day; 2, 9 to 10 days; 3, 14 to 19 days; 1, 15 months; average, 64 days.

⁵ G 2. \times homer; 6 young lived—1, 10 months; 2, 12+ months; 3, 20 months; average, 470+ days.

⁵ G 2. \times domestica; 9 young lived—6, 5 to 10 days; 1, 14 days; 1, 11 months; 1, 30+ months; average, 142+ days.

The data thus far considered lead, then, to the conclusions which are generally supported by the data from other groups: (1) that fertility is a matter of all degrees; (2) that proper crosses enable one to see and study the intergradations and flowing levels of this important function; (3) that hybridization, even within the limits of the breeds of common pigeons, makes their ova less compatible with the sperm of one wild species; and (4) at the same time sets a sentence of a shorter term of life upon the developments which proceed from their more compatible gametes.

The non-equivalence of the two eggs of the clutch, particularly well seen in cases where there can be but little development (as in $G\ 1 \times E\ 2$), has also been indicated. It remains to point out that these data further show that germs produced at the extremes of the seasons are weak in developmental power; fewer of such eggs develop, and shorter lived offspring arise from them. This result can here be best presented⁷ in a table showing the outcome for the eggs of each month of the year. Eliminating the record in Series II for the whole years in which no fertile eggs were produced, the data are as shown in table 66.

It will be seen that the "highest fertility" and "longest life" are both resident in the eggs produced in May. The second for fertility is April; the second for longevity is March. The lowest fertility is found in December, January, February, and August.

⁵ The egg of greater developmental strength and of male-producing tendency seems in domestic pigeons, even of so-called "pure strains," to bear no definite relation to the order of the eggs in the clutch. This is as in hybrids generally.

⁶ By "pure" of course only "relatively pure" is meant when speaking of common pigeons.

⁷ All such methods of grouping and treating data not entirely homogeneous are of course open to objection but an estimate of the situation under analysis can be thus presented.

That individual homers differ (or that the male guinea-pigeons differ) in respect to fertility is amply shown by the different results obtained from the homers *E 2* and "2-barred of 1903." Of the eggs of the former only 8 of 22 tested showed any development; the longest life of offspring here was 19 days (with *G 1*). In contrast, 7 of 10 eggs of the other homer were hatched (mated to *G 1* and *G₂ 2*), and all the offspring lived from 10 to 20+ months.

TABLE 66.—*Fertility and length of life from eggs (guinea-pigeon series) laid during various months of the year.*

Month.	No. laid.	No. tested.	No. fertile.	No. infertile.	P. ct. of fertility.	Length of life.
March.....	7	5	3	2	60	5 days, 19 days, 15 months.
April.....	15	15	10	5	67	1 day embryo, 3 hours, 5 days, 7 days, 9 days, 10 days, 10 days, 12 to 13 days, 14 days.
May.....	10	7	6	1	86	1 day, 10 days, 11 months, 12+ months, 20+ months, 30+ months.
June.....	8	7	3	4	43	9 days, 5 to 7 days, 5 to 7 days.
July.....	16	16	9	7	56	15 day embryo+, 7 day, 7 day, 7 day, 14 day embryo; 10 months, 12 months, 7 days, ? 7 days.
August.....	5	3	1	2	33	7 days.
September..	3	2	1	1	50	7 days.
October....	8	8	5	3	62	5 days, 8 days, 18 days, 19 ¹ ₂ months, 20 ¹ ₂ months.
November..	2	2	1	1	50	14 days.
December..	1	1	0	1	0	
January...	3	1	0	1	0	
February...	4	2	0	2	0	

One further point should be considered, namely, the reproductive disturbances appearing in the hybrids of these two series. No narrowly limited number of hybrids, from a primary cross, will present many cases of reproductive abnormalities or disturbances; each of the two present series contains one. In the mating of *G 1* × homer *E 2*, where we noted in the preceding paragraph very restricted fertility and short life of offspring, one of the young (*J 1*) lived 1 day longer than any of its fraternity; nevertheless at 19 days old it had no evident sex-glands. Professor Whitman's records show numerous isolated instances of this sort of thing, though he has nowhere commented upon the matter. The editor has, however, made a great many autopsies of the birds of the author's collection and of many others bred by himself, and is convinced that such histories as that of *J 1* now under consideration is typical of a small but notable fraction of the hybrid offspring of doves and pigeons. *Some hybrids—a much higher proportion than pure breeds—develop no sex-glands, or they develop diminutive or otherwise abnormal ones.*

The second instance of reproductive abnormality in this group is of another kind. This is the instance tabulated in table 65, in which a hybrid daughter (*guinea* × *domestica*, *C*) mated perfectly with her sire, but in 4 months of mating produced no eggs. Nor are there any later records of eggs from this bird. A record of an autopsy of this bird can not be found, but she is unqualifiedly listed as a female, and certainly behaved as one; if in reality she had male sex-glands, then her reproductive abnormality would lie in this feminine behavior.

The sex data for the offspring of *G 1* and his consorts (the less-fertile series) are: 3 males and 1 unsexed (?) bird of 19 days. The more fertile series (*H*) gave 3 males and 5 females. Four of these 5 females arose from the most fertile—and otherwise the most normal—mating of either series.

One would wish to know what the reciprocal of this cross (σ common \times ♀ guinea) would show. Only a single mating of this sort is recorded, and from this but a single clutch of eggs was obtained. The data are:

σ C. domestica; black with chequers. A 1. 5/27/10; dead 3 days after hatching.

♀ C. guinea (19); dead 6/22/10 A 2. 5. 29. 10; no development.

(P 5)

Matings and Back-Crosses of Guinea Hybrids.—In the mating and back-crossing of guinea-homer hybrids many of the fertility and longevity features of the primary cross reappear—low fertility, seasonal and individual differences of fertility, and a shortened life-term of the offspring. Nevertheless, this term of life is here an advance over the longevity of the primary cross, where, however, the life-term was *extremely* short.

Three matings involving 4 individuals of the second generation guinea hybrids ($\frac{1}{4}$ guinea, $\frac{3}{4}$ homer) were made. The sires of the first two matings were brothers. Two were mated back to homers. The results, placed in table 69, show low fertility for the pair of inbred secondary hybrids, but fair fertility and perhaps longer life-terms than were obtained from the primary hybrids. Two birds from secondary hybrids lived for 27 months, one lived 32 months. This seems to be near the extreme limit of life of these hybrids from species whose individuals usually live probably 5 to 15 years.

One additional point is indicated by the result of the matings of the primary hybrids, namely, that the males seem more fertile in the back-cross than are the females. Three of each were tested with homers. From all the matings of such males eggs (9) were hatched. Not one egg from the pairing of female primary hybrids with male homers was hatched; only 3 of their germs showed any fertility, and there was a minimum of growth in these—a “circle of blood,” a “little development,” and again a “little development.”

TABLE 63.

Series I.

σ C. guinea (1); escaped April 1904.

♀ C. tabellaria (E 2); 8/24/99.

A 1. 4/26/00; no development.

A 2. 4/28/00; dead 3 hours after hatching (partly helped from shell).

B 1. 5/24; dead 24 hours after hatching (partly helped from shell).

B 2. 5/26; no development.

C. 6/5; data later rejected (by the author).

D 1. 6/19; no development.

D 2. 6/21; dead at 9 days after hatching.

E 1. 8/2; no development.

E 2. 8/4; no development.

I 1. 2/15/01; no development.

I 2. 2/17/01; no development.

?J 1. 3/4; dead, 19 days after hatching.³

J 2. 3/6; no development.

σ F 1. 10/24; dead 18 days after hatching.¹
F 2. 10/26; no development.

G 1. 11/20; no development.

?G 2. 11/22; dead 14 days after hatching.²

H 1. 12/30; no development.

H 2. 1/1/01; no development.

K 1. 4/5; no development.

K 2. 4/7; “formed only a circle of blood.”

L 1. 4/20; no development.

L 2. 4/22; dead 10 days after hatching.⁴

(G 5, A 14)

¹ “*F* 1 remained healthy and strong, and I was greatly surprised to find it dead on the morning of Nov. 28. I can not imagine the cause unless some organic defect that appeared quite suddenly as a result of the development, and not of disease.”

² “The bird did well until the morning of Dec. 22, 1900, when I noticed the vent soiled with a greenish discharge, and concluded the bird was fated to die soon. I gave it a tonic tablet, and watched it. It grew worse rapidly and at 10 o’clock I found it dead.”

³ “The bird appeared perfectly well the day before he died and was well fed. * * * The sex = ? I could not discover any sexual organs.”

⁴ “On the evening of May 18 I noticed the bird was wet about the anus. This watery discharge, in some cases greenish, is a sure precursor of death.”

TABLE 64.

Series I—Continued.

σ^{δ} C. guinea (1).	
♀ Owl-rock hyb. (C 1); 1/19, 01.	
A 1. 6/18/01; no development.	G 1. 2/16/02; thrown from nest.
A 2. 6/20/01; no development.	G 2. 2/18/02; thrown from nest.
B 1. 7/14; no development.	H 1. 3/27; not hatched.
B 2. 7/16; opened 7/31 (too soon) a live embryo.	H 2. 3/29; not hatched.
C 1. 7/31; died about 7 days after hatching.	I 1. 4/23; dead at 10 days after hatching.
C 2. 8/2; died about 7 days after hatching.	I 2. 4/25; some development.
D. 9/1; broken (not sure about second egg).	J 1. 7/1; no development.
E 1. 10/1/one dead about 8 days after hatching.	J 2. 7/3; no development.
E 2. 10/3/one dead about 5 days after hatching.	K 1. 9/25; dead at 7 days.
F 1. 1/15/02; no record, ? no development.	K 2. 9/27; no development.
F 2. 1/17/02; no record, ? no development.	L 1. 10/27; no development.
	L 2. 10/29; no development.
σ^{δ} C. guinea (1).	
♀ Owl-rock hyb.; (of 1902); black-chequered.	
A 1. 4/26/03/one, no development; other dead at 12 to 13 days.	
A 2. 4/28/03/one, no development; other dead at 12 to 13 days.	
B 1. 5/16; no record.	C 1. 7/13; dead at 7 days.
B 2. 5/18; no record.	C 2. 7/15; probably no development.
	D 1. 8/15; no record (? no development).
	D 2. 8/17; no record (? no development).
σ^{δ} C. guinea (1); (escaped April 1904)	
♀ C. tabellaris; (1903); 2-barred.	

σ^{δ} A 1. 3/20/04; (1); lived till June 1905; disappeared at 15 months; mated with a homer, but no eggs laid.
A 2. 3/22/04; no record, probably no development

(G 5, A 14)

TABLE 65.

Series II.

σ^{δ} C. guinea (2); probably imported; no record of death.	
♀ C. affinis domestica (RK 4); medium chequered; died 8/20/01.	
A 1. 3/30/01; dead at 5 days; healthy day before. ¹	
A 2. 4/1/01; dead at 5 days; healthy day before.	
B 1. 4/14; dead at 14 days "perfectly well at 7 p.m. of this day, sudden collapse a mystery."	
B 2. 4/16; dead at 7 to 10 days.	
C 1. 5/1/one, a ♂, dead (cholera) 4/2/02; 11 months; fertile.	
C 2. 5/3/one, a ♀, alive 11/10/03; 30+ months; not fecund with sire (see text-fig. 8, page 217.)	
D 1. 6/1; dead at 5 to 7 days.	E. 7/13; developed (opened prematurely).
D 2. 6/3; dead at 5 to 7 days.	
F 1. 7/28 (0); "dead at few days" after hatching.	
F 2. 7/31; egg laid late; no development!	
σ^{δ} C. guinea (2).	
? ♀ guinea × domestica hyb. (C) of 5/2, 01.	This sire and daughter mated Dec. to Mar. 16, '02, but laid no eggs!
σ^{δ} C. guinea (2).	
♀ Owl × rock hyb. (pale-chequered).	
A 1. 4/3/02; no development.	C. 6/7; no development.
A 2. 4/5/02; dead at 7 days.	
B 1. 5/4; dead at 10 days old! (best of care).	D 1. 7/12; dead at 7 days.
B 2. 5/6; no record; probably no development.	D 2. 7/14; dead at 7 days.
Birds separated winter 1902-3.	
E 1. 3/29/03; no development.	G 1. 5/23; no development.
E 2. 3/31/03; no development.	G 2. 5/25; no development.
F 1. 4/16; no development.	H 1. 6/7; no development.
F 2. 4/18; no development.	H 2. 6/7; no development.

(P 3, A 14)

 σ^{δ} C. guinea (2).

♀ Owl × rock hyb.; (2 years old when placed here); dark chequers.

A 1. 3/24/04; no development.
A 2. 3/26/04; no development.

¹ "First time both eggs in such a cross have hatched. Age at death=A 1, 5 days; A 2, 5 days."

TABLE 65 (*continued*).

A fifth female, a homer (*C. tabellaris*, then in second year) given to this male on 5/7/04; this same homer mated earlier in 1904 with *C. guinea* (1) producing 2 eggs before:

♀ A 1. 5/12/04 (2)	hatched, alive May, 1905	12+ mo.
♀ A 2. 5/14/04 (3)	hatched, matured; mated with homer, alive Dec. 1905	20+ mo.
B 1. 7/4; no development.		
B 2. 7/6; no development.		
♀ C 1. 7/28 (4)	dead 5/29/05	10 mo. (confinement?).
♂ C 2. 7/30 (5)	dead 8/12/05	12½ mo.; fertile with homer.
♀ D 1. 10/10 (6)	dead 5/25/06	19½ mo.
♂ D 2. 10/12 (7)	dead 6/22/06	20½ mo.

This ♂ tested (for sixth time) with his daughter—a ♀ guinea × homer hybrid (2); their eggs of 4/13 and 4/15/05 were incubated, but neither showed any development.

TABLE 67.—*Male guinea-homer hybrids back-crossed to homers.*

♂ Guinea-tabellaris hyb. (1); 3/20/04; disappeared June 1905.	
♀ C. tabellaris (C2—3); 3/13/01.	

A 1. 3/11/05; "hatched, with help, after 19 days, 20 hours; lived 1 day, too weak to feed."

A 2. 3/13/05; "little or no development."

B 1. 4/8; no development.

C. 5/11; no record; probably no development.

B 2. 4/10; no development.

♂ Guinea-tabellaris hyb. (7); 10/12/04; 6/22/06; 20½ mo.	
♀ C. tabellaris (C 2—3).	

AA 1. 6/29/05 } from another sire, not (7); both eggs hatched.

AA 2. 7/1/05 }

♂ B 1. 7/29 G7B	mated with a homer; dead 7/30/06	12 mo.
♀ B 2. 7/31 G7B	mated with a rock.	
C 1. 9/15 G7C	disappeared 11/?/05	2+ mo.
♂ C 2. 9/17 G7C	alive 5/6/06	

Other eggs laid and hatched; not sired by hybrid (7), except 1 in 1906.

G. 5/15/06. G7G. dead at 7 days.

♂ Guinea-tabellaris hyb. (5); 7/30/04; 8/12/05; 12½ mo.	
♀ C. tabellaris (A) from fancier 1905; chequered.	

A 1. 4/17/05; deserted.

B 1. 5/11; hatched, dead at 12 days (cold?).

A 2. 4/19/05; deserted.

B 2. 5/13; some development.

♀ C 1. 6/28 C5C	alive Nov. 1906	17+ mo.
C 2. 6/30; hatched; dead at 23 days.		(P 4)

TABLE 68.—*Female guinea-homer hybrids back-crossed to common pigeons.*

♂ C. tabellaris (9) 1904.	
♀ Guinea-tabellaris (3); 5/14/04; alive 20+ mo.	

A 1. 3/25/05; no development.

C 1. 5/12; no development.

A 2. 3/27/05; no development.

C 2. 5/14; no development.

B 1. 4/17; no development.

D 1. 6/17; no development.

B 2. 4/19; no development.

D 2. 6/19; no development.

E 1. 7/7/05; no development.

E 2. 7/7/05; no development.

F 1. 12/17; no development.

F 2. 12/19; no development.

♂ C. tabellaris from fancier 1905.

♀ Guinea-tabellaris (6); 10/10/04; 5/25/06; 19½ mo.

A 1. 7/9/05; no development.

B 1. 1/22/06; one, no development.

A 2. 7/11/05; "circle of blood."

B 2. 1/24/06; one, a little development.

♂ C. domestica (7).

♀ Guinea-tabellaris (4); 7/28/04.

A 1. 5/7/05; one no development.

A 2. 5/9/05; other a little development.

(P 4)

TABLE 69.—*Matings of secondary guinea-homer hybrids.*

σ^2 Guinea-tabellaria \times tabellaria (G7C); 9/17/05 (brother).	B 1. 9/12; no development.
♀ Guinea-tabellaria \times tabellaria hyb. (G5C); 6/28 '05 (sister).	B 2. 9/14; no development.
A 1. 5/20 '06; no record, probably no development.	B 1. 9/12; no development.
A 2. 5/22 '06; no record, probably no development.	B 2. 9/14; no development.
σ^3 (C 1. 10/25) one σ^2 G7C-C, mated with homer (hatched 2 young), dead 6/27 '09 = 32 mo. (pl. 54, Vol. I.)	
C 2. 10/27) one no development.	
<hr/>	
σ^2 Guinea-tabellaria \times tabellaria hyb. (G7B); 7/29 '05; 7/30 '06; 12 mo.	
♀ C. tabellaria.	
A 1. 4/17/06.....G 7 B-A ¹.....dead 7/30/06.....	.....2½ mo.
A 2. 4/17/06.....G 7 B-A.....dead or disappeared before 5/20/08.	
B 1. 5/24.....G 7 B-B.....dead or disappeared before 5/20/08.	
B 2. 5/26.....G 7 B-B.....dead or disappeared before 5/20/08.	
<hr/>	
σ^2 (½ guinea, ¼ tab.) G 7 C-C of 10/26, 06 of the mating above; mated early 1908.	
♀ C. tabellaria; escaped 5/20, 08.	
σ^2 A. 3/15/08.....G 7 C-C-A.....dead or disappeared before 2/5/11 (pl. 54, Vol. 1).	
σ^2 B. 4/21/08.....G 7 C-C-B.....mated w. homer (K 4)=1 young; escaped 3/27/09=11+ mo. (pl. 54, Vol. I.).	
<hr/>	
♀ C. tabellaria (K 4) given to this σ^3 , 1909.	
♀ A 1. 4/25/09; dead 7/13/11; 27 mo.	
A 2. 4/27/09; hatched; no record of death.	
B 1. 6/1; sick; killed at few weeks or months.	
σ^2 B 2. 6/3; dead 9/11/11; 27 mo.	(P 4)

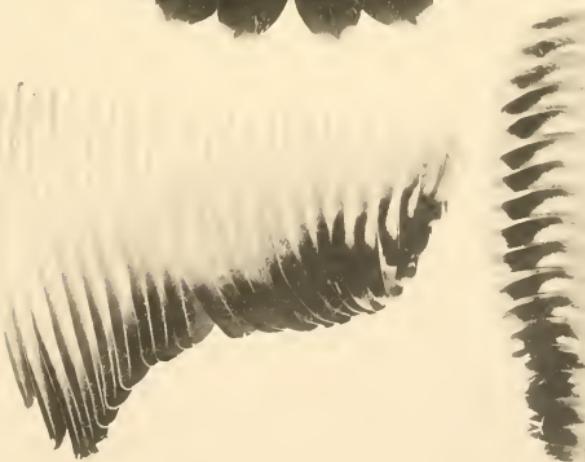
¹ Where two birds were given the same tag numbers (as here) the birds were distinguished by the tag being on right or left leg.—EDITOR.



A



B



C



D

Common pigeon hybrid (5-E2, from common \times homer) with whitened bars from early breeding. Hatched June 4, 1909; age 6 weeks. The sire of this bird was 6 months old; the dam about 7 months old. Figs. B and D show the nature of the whitening, in particular feathers plucked when the young was 7 weeks old.

- A. General coloration and whitening in the wing.
- B. The expanded tail.
- C. The primaries, secondaries and tertials.
- D. The first row of wing-coverts.

CHAPTER IX.

BREEDING AND INBREEDING FOR COLOR IN SOME DOMESTIC PIGEONS.

In the mating of individuals of essentially the same breed of common pigeons there can sometimes be obtained evidence that white and red color tend to appear mostly in the later offspring of the season. From the very first effort of the season also, particularly when immature birds are used as parents, these colors are relatively frequent. "Weak germs" are equally responsible for the white or red in both cases. In many cases these striking color variants show other abnormalities or marks of physical degeneracy. The several agencies or factors other than season which similarly affect color, fertility, and sex are also prominent in some of the several series of matings brought together here. Fortunately, the author has written rather fully of the causes of weakness of many of the offspring of these matings; throughout this chapter these statements by the author are given the form of quotations.

The common pigeons most studied were homers, barbs, pouters, owls, and common rocks. Three or four crosses of these forms with nearly related wild species have been added for the sake of completeness and in order to supply the original data for the fertility and sex summaries of Chapter II. It need scarcely be remarked that here, as elsewhere, all of the data available, not a selected part of it, is presented.

COLOR AND WEAKNESS IN HOMERS.¹

The results of mating a pair of common pigeons during a part of 3 years are presented in table 70. The last pair of eggs, from each of the two included autumns, hatched birds with much more of white color than was present in any of the birds hatched from the earlier part of the season. Two of these young are shown with their parents in plate 14. The whitened birds of the second autumn were followed in the succeeding year by birds of normal color. The very earliest egg of the second season, moreover, hatched a bird (No. 5) of fairly normal plumage, but its weakness was revealed by breeding. This male *E 1* (or No. 5, hatched January 15, 1909, of the progeny of table 70), was mated in May 1909 with a female homer, hatched November 15, 1908. It will be noted that this male came from ♂ red guinea × ♀ black guinea, and that, as stated by the author, "both of its parents were strong² birds; but this young male (5) had one white primary and three white primary coverts (the latter in both wings), and came at the beginning of the season of 1909. At the time of getting his *first* young this male had, therefore, nothing to indicate weakness, except that he was only 6 months old. His breeding power should be highest at the age of 3 to 6 years. The female (*E*) with which *E 1* was mated came from an old but strong homer (a few chequers). Her dam was a light gray *two-barred* homer, that had one drooping wing affected with *tuberculosis* in the joint. The points of weakness in the dam of *E* were, then, *lateness in season* and *tuberculosis*, difficulty in flight, and death in May following.

¹ A mating of mongrel common pigeons whose progeny were crossed with homers is more conveniently presented here than elsewhere.—EDITOR.

² It is elsewhere noted that this bird (and some of her brothers and sisters) had "frills" in some feathers of the wing (pl. 71, Vol. I) and that this often accompanies weakness.—EDITOR.

"The points of weakness in the daughter (*E*) were shown especially in the *obsolescent* bars, the right second bar being scarcely more than a shadow of a bar, and again in her *young age*, being only about 7 months old. Her nest mate was a *sister* (also No. *E*), and two females³ from a clutch show weakness in parents, and weakness in parents leads us to expect it in the young. Furthermore, this dam was hatched November 15 from an egg laid at the *end of October*—at a time of lowest energy in the parents." (XG 24, R 16)

This pair of weak parents produced the following:

A 1. (5 E-1) hatched 6/4 '09; dead before 2/1 11; moderately chequered, black without white.
 ♀ A 2. (5 E-2) hatched 6/4 '09; dead on 10/15/09; whitened (see pl. 15).

When 6 weeks old the second young (A 2 or 5 E-2) was examined, photographed (pl. 15) and described. White color was in evidence; the two dark bars present were invaded by white advancing from the feathers' tip. "This whitening of the bars of the young was the result of *parental weakness*" (R 16). At the same time, feathers were plucked to learn the color of a second plumage.

"On October 15, 1909, 3 months after plucking, the bird has made but very little progress in moulting. The plucked secondaries have been replaced, but still show white to about the same extent as before. The outer primaries (5 or 6 of them) have not yet come out, and apparently they are at a standstill. The right wing still remains intact and not more than half a dozen juvenal feathers have been moulted. The bird seemed drooping or sick for a week or two before death on the above-named date, but has had a good pen and good care. I find that the tail feathers have been replaced and have come out with the original amount, or very nearly, of the *white*. It turns out to be a female. The liver was somewhat blackened, and the intestine was swollen and full of watery contents. The early death again testifies to *physical weakness*. The result—whitened bars and whitened tail feathers in the offspring⁴—is thus well accounted for without the aid of specific determinants." (XG 24, R 16)

The first mating of pure homers to be described involves a male homer (Hom. 1) whose fertility had previously been tested with birds representing three different genera, all of a different family from that to which the homer belongs. This male had successfully produced young with two of these genera, and had failed to fertilize eggs (4 tests) of the most modified or divergent⁵ of these 3—the crested pigeon of Australia. After these tests of his fertility he was mated with a homer (Hom. 3), and still later with his daughter. Varying degrees of fertility (reduced in all) were shown in the family crosses with the various genera used—*St. risoria* (*M* 2 and *F* 2), *T. orientalis* (2), *Ocyphaps lophotes* (*Cp*). When this bird was paired with his own kind practically all eggs were fertilized; with his daughter also he was fully fertile.

This "fairly strongly" chequered and highly fertile male was mated with a strongly chequered (dark) female to see if birds darker than either parent might be

³ The italics of this entire quotation (this and the two following quoted paragraphs) are those of the author. Almost everywhere, in the author's later manuscripts which deal with breeding, one finds a word or two on the immediate particular factor or factors associated with a particular group of weak germs. Probably nowhere better than in these paragraphs has he written of a number of them at once.—EDTRN.

⁴ "Horwood (Nature, June 11, 1908, p. 126—Coloration of Bird's Eggs) notes that, 'The intensity of coloration varies with age up to a certain point. Eggs of young birds are often unspotted. Absence of markings is doubtless due to deficiency of pigmentation. The last egg or eggs of a second brood, in fact, often lack normal coloration or markings.' Age and health thus control the coloration, which is brilliant in a healthy but indistinct in an unhealthy bird's egg." (R 16)

⁵ See Vol. 1, table 2, etc.

obtained. It will be seen by reference to table 71 that *lighter* but not *darker* birds resulted. Nine young were certainly intermediate to the two parents in color. Two were as dark as the darker parent, two were similar to the lighter colored parent, and four—"plus the several birds raised by Ollson during the winter of 1900-1—had only gray color with two black bars." The number of offspring of lighter color than either parent was therefore probably between 9 and 12. The two sexes are known to have been represented in nearly all of these various groups. It is also notable that the *greater number of these lightest colored individuals were from the weakened germs of autumn and winter.*

Adequate color descriptions can be found for only two of the offspring of the sire \times daughter mating. One was as light as the lighter parent, the other was intermediate.

Two of the very darkest of the offspring (of homers 1 and 3) were mated, brother to sister, to see if their dark color might be increased to pure black. It will be seen that progress in this direction—by *inbreeding*—was not accomplished.⁶ On the contrary, unexpected *white* and *red* appeared, as did also *asymmetrical* developments in the first 3 offspring of these very young parents. Only 6 offspring were probably as dark as the parents. The young whose color throughout was as dark as that of the parents were from eggs laid February 20, 1902; April 3, 1902; May 12 and 14, 1902; February 2, 1903; April 15, 1903; and June 4, 1903. It is therefore clear that more whites and reds and more defectives arose when the parents were very young and from eggs laid late in the season.

The *inbreeding* of the young (of homers 1 and 3) was further carried out as follows: Two of the offspring⁷ of the above pair produced 8 young for which we have some data.⁸ Here it is notable that the first pair of eggs of which we have a record threw birds which were gray with only two bars; and that each of the three succeeding clutches contained a bird with *red chequers*. (BB 9)

σ C 1. hatched March 5, 1901; even gray, 2-barred.

σ C 2. hatched March 6, 1901; gray, 2-barred.

"This pair, then (after the two young listed above), produced three successive pairs of young, each time *one black-chequered* and *one pale red-chequered*." The latter hatched as follows:

- (1) ♀ hatched about May 15, 1901; died May 5, 1902.
- (2) — hatched about June 20, 1901; died September 15, 1901.
- (3) — hatched about August 8, 1901.

One of the above gray 2-barred males (*C 1*) was mated in 1902 to a related homer. This related female (*C*) was from the mating recorded in table 76, this latter bird being a sister to both parents of *C 1*. It will be seen (table 73) that the further inbreeding of the pair now under consideration gave only 2-barred and 2-reddish-barred offspring, with some infertile eggs.

The further inbreeding of two of the young from the brother-and-sister mating described in table 72 brings out much more forcefully the effect of inbreeding upon the developmental strength of germs. Only in their second (and third?) year

⁶ For further statement on this "selection experiment" see Chapter II (and illustrations), Vol. I.

⁷ ♂B 1 and ♀A 1, via K 1 and J 2, from eggs December 28, 1900, and October 26, 1900, respectively.

⁸ The complete record of this mating can not be found. The above data are taken from scattered statements and the one much-abridged summary given above in the author's words.

were the germs of these birds capable of any development. The early part of the season, after a long rest, too, was the time of greatest fertility. Not a single young was reared from 28 tests (table 74).

It was shown above that a selection of the blackest progeny of dark homers for brother-and-sister matings did not lead to the production of darker progeny, but to a majority of offspring of lighter or redder color than parents or grandparents; it was indicated also that weakening effects (inbreeding, etc.) were responsible, in part at least, for this result.

The reverse of the above experiment was also studied. In this experiment light-colored homers (few chequers and small bars) were selected as parents in an effort to obtain offspring of still lighter color. This effort was successful (Chapter II, Vol. I). Table 75 shows, however, that it succeeded best when sire (darker of original parents) was mated to daughter (lightest and narrowest bars), and from eggs laid late in the autumn (August and November); 3 of the 4 eggs then produced gave rise to birds with weaker bars than had any of their known ancestors.⁹ This situation, moreover, was continued in the succeeding germs which were laid "out of season." Two photographs (pl. 16) assist in making clear the measure of success attained in this experiment. In the first mating listed in table 75 the parents were unrelated; the lightest colored young of this mating developed from eggs laid outside of the usual breeding season, during autumn and winter.

Another mating for a period of 5 years was made in the effort to produce 2-barred homers from 3-barred parents one of whom had chequers as well as 3 bars.

⁹ The fourth had bars equal to the least developed bars of a parent, and was of lighter color.

EXPLANATION OF PLATE 16.

A. Two juvenal homers, brother and sister to the pair figured below. Hatched from a clutch (*H 1* and *H 2*) just preceding young of fig. B; also the parents of these two pairs of young.

On the extreme left is *H 1* in juvenal plumage; it presents another distinct step towards the complete *obliteration* of the bars of the wings and also of the tail. This bird has a typical homer build or form, but has a single feather turned outward (frill-like) in the middle of the upper breast. The ground-color is a distinct shade lighter than the ordinary rock-gray. Head and neck decidedly lighter than in rocks, a shade of rusty brownish in the neck. In place of the subapical black band in the tail there is a very pale whitish-gray band, about 17 mm. in width, with an apical dusky-gray border about 7 mm. in width. Rump whitish gray.

The wing-bars have lost the black almost wholly, leaving a paler gray than in the rest of the wing; and this paler gray is lightly touched with brownish and bordered posteriorly with a narrow, ill-defined dusky line, varying from 1 to 2 mm. in width. Both bars are in essentially the same condition, but we may note that in the posterior bar the black is practically a faint trace of brownish. In the tertials this posterior bar is nearly of the same color as the anterior bar, but on the inner 3 or 4 tertials 2 to 3 dusky "fundamental bars" cross the outer web of the feathers. *This bird makes a near approach to complete loss of wing-bars.* At a little distance it appears to have no bars, or only shadowy indications of lost bars.

On the extreme right is *H 2*; it is clear rock-gray in color, and has narrow black bars about the same as its mother. It has the usual subapical tail-band; the rump is white. The anterior bar has a width of 9 mm. on the inner coverts and gradually narrows to 5 mm. just below the middle of the row of coverts. The posterior bar (on 6 inner tertials) has a greatest width of 17 mm. on the fourth tertial; it becomes freckled with gray on the seventh tertial and is nearly obliterated on the eighth.

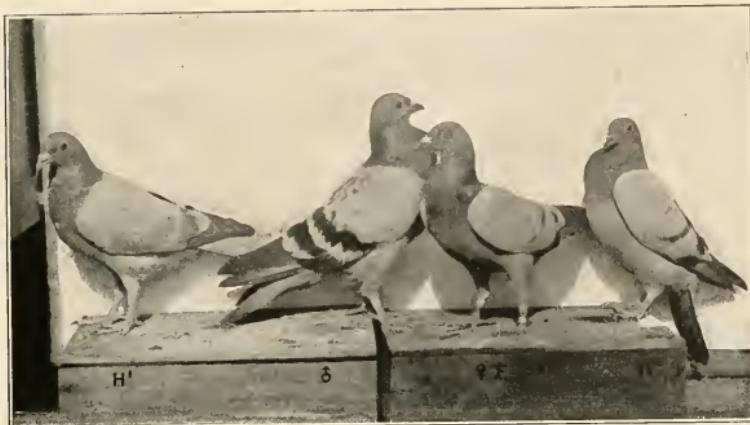
The two parents are shown at the center of the figure.

B. Juvenal homers (*I 1* and *I 2*) with light color (in *I 1*) and with wing-bars reduced. Photographed Jan. 19, 1910, at the age of 6 weeks 4 days.

These birds from sire mated to daughter (table 75), and from eggs laid in very late autumn, Nov. 15 to 17, 1909. Juvenal *I 1* (on left) has rock-gray color with four squarish black spots on the outer web of the inner tertials. The first and fourth spots are a little smaller and weaker or thinner than the second and third, which measure 10 by 8 mm. and 13 by 8 mm., respectively. Below these spots there are only scattered freckles which are too weak to figure as spots. The appearance is thus practically what we see in the stock-dove (*C. annas*). The anterior bar has no spots, but just freckles enough to indicate a trace of a bar when closely examined.

Juvenal *I 2*, color almost white or silver gray.

A



B



- A. Homers, brother and sister to the pair figured below. Hatched from a clutch (H^1 and H^2) just preceding the pair shown in the lower figure; also the parents of these two pairs of young.
- B. Juvenal homers (I^1 and I^2) with light color (in I^1) and with wing bars reduced. Photographed Jan. 19, 1910, at age of 6 weeks 4 days.

The color records are adequate, or nearly so, in the cases of 22 young. They fall into the following groups: Intermediate, 12 (+?4); lighter than lighter parent, 5 (+?2); darker than darker parent, 1; infertile 4. The seasonal distribution of these very light colored birds is of chief interest, and an examination of the appended table (76) shows that 4 of the total of 5 arose from the first or the last clutch (hatched) of the year; the other very light colored bird hatched from the last clutch of which we have a record in 1904. The four eggs that failed to develop were all from the extreme end of the year. Three of these lightest colored offspring are from the two clutches immediately adjoining a pair of infertile eggs.

Still another of the offspring (marked *F 1*) of the mating $\sigma B 1 \times \varphi A 1$ was mated with a consort that seems¹⁰ to be *I 2* (from egg of January 24, 1900) of homers 1 and 3 (see table 71). The parents of *I 2* are therefore at the same time all of the grandparents of *F 1*. *F 1* was gray with 2 bars; the female *I 2* was chequered a little less than her least chequered parent (Hom. 3). Only 4 eggs are recorded, but it is of interest to note that the first pair (Feb. 3 and 5, 1900) of these (also ?first in life) were incapable of hatching, and that the second pair of eggs (Mar. 5 and 7, 1900) both hatched birds with the reduced barring—2 bars, without chequers. (BB 9)

Records were kept for a few other pairs of inbreeding homers, but those pairs were not confined to a cote; and since such females might secure fertilization from other males (as noted by the author), all such pairings have been excluded from consideration in these pages.

BLACK, RED, AND GRAY BARBS FROM BLACK PARENTS.

The following experience with black barbs (a domestic variety) indicates that the sliding scale of fertility elsewhere elaborated is accompanied by a change or reversal of the dominance of color. The dominant black becomes but partially dominant under a series of conditions that weakens germs, *i.e.*, inbreeding, late season, and immaturity of parents (possibly also, second egg of the clutch). Red and gray colors appear under these conditions, as will be seen by an examination of the data of tables 77 and 78.

A red male (*K*) from these black barbs was mated in 1906 with a red-and-white barb. It is certainly interesting, in view of the foregoing situation, that this immature red male mated to a (possibly immature) red-and-white bird should throw nearly or quite as many black as red, whereas the several inbred black barbs mated to other black barbs threw nearly as many non-black (red and gray) as black; and indeed a much higher proportion of non-black in the periods of "weakest germs." These data are included in table 78.

In all of the above matings where more than one color appeared, it will be observed that there hatched 15 black, 11 red, and 4 gray. But in spite of this predominance of black (even where black was not the *exclusive* or only color), the last egg of the season was never known to produce a black, though 3 such threw red and 1 gray (2 did not develop). And, further, where two colors appear from a single clutch the second egg never produced the predominant black, though the rarer red bears such a relation in three cases. It is not surprising to find black

¹⁰ In this case the editor is not positive that he has the right history of the birds concerned in the mating. It is probably right as stated.

barbs throwing some red and some gray offspring; the importance of these data lies in the suggestion that these colors arise from the "weaker germs," and in the evidence furnished by this group for the genetic non-equivalence of the two eggs of the pigeon's clutch.¹¹ It is clear that the color of the red birds at least is not changed secondarily through a change of sex, since birds of both sexes were of this color.

PHYSICAL DEGENERACY AND RED-AND-WHITE COLOR ASSOCIATED WITH LATE SEASON AND WITH INBREEDING IN GRAY BRÜNN POUTERS.

A few gray Brünn pouters were bred for two or three years. The number of pairs and the number of young are not large. The results, however, clearly support other data indicating, (a) that the first egg of the season and the autumn eggs are "weak" germs; (b) that white and red colors and physical degeneracy are here associated with the periods of "weak" germs; and (c) that in inbreds degeneracy and red and white colors readily appear. The data for (a) and (b) were obtained from a mating in 1908-9, and are fully given in table 79. The female of this series hatched 12 young in 1908. The colors of the first, eighth, ninth, tenth,¹² and twelfth (Nov. 11) of the season showed weakness of coloration (red or white). The eighth, ninth, and tenth (late autumn) show unusual red or white; the tenth

EXPLANATION OF PLATE 17.

- A. Juvenal pair (*C 1* and *C 2*) of gray pouters from a brother-and-sister mating (pair 3 of table 80). Photographed at 7 weeks.

C 1 (to the left) was of nearly normal color (see table 80, pair 3).

C 2 (to the right) is quite a departure; it is practically white-barred throughout, i.e., every row of feathers on the wing is white, broadly tipped with brown orange. The bird has varicating legs to some extent and is a weakling, though not conspicuously so in other respects than the excess of white color and leg varication. It has a white band in the tail and "frills" in the tertials.

- B. Juvenal pair (Nos. 8 and 9) of pouters from gray (white-barred) parents; 12 weeks old (see table 79).

The great unlikeness of the two young is shown. The one (No. 9) was white, and was unable to fly. The primaries were not well developed and were not closed, but hung at many angles. The legs sprawled apart, so that walking was very awkward. The bird ate well, but had a very shaky behavior; the head-movement was not normal but shaky, as in high-bred fantails. The bird was a degenerate. The mate (8) was a fine, sleek bird, well developed and perfect in feather, but also a degenerate in color and in failure to lay eggs. When adult the red-black wing-bars (shown in the illustration for the juvenal) turned to white with black borders, but retained a tinge of red. The latter bird is higher in development than the former.

EXPLANATION OF PLATE 18.

- A. Adult gray pouters (son and dam; see table 79) and one of their offspring (*J*, Aug. 5, 1909; see table 79) in juvenal plumage. ♀

The sire and dam (to right and left) are similarly and normally colored.

The young bird (*J*) stands in the center. The photograph was taken at 7 weeks and shows the rock-gray color and presence of two black bars.

- B. Adult gray pouters (male No. 4 and female No. 6 of table 79), and two of their color-modified offspring (*E 1* and *E 2* of August 9 and 11, 1909; see table 80). Photographed Oct. 16, 1909; the young at 7 weeks old.

The adult male stands to the left (front); the female stands behind the male.

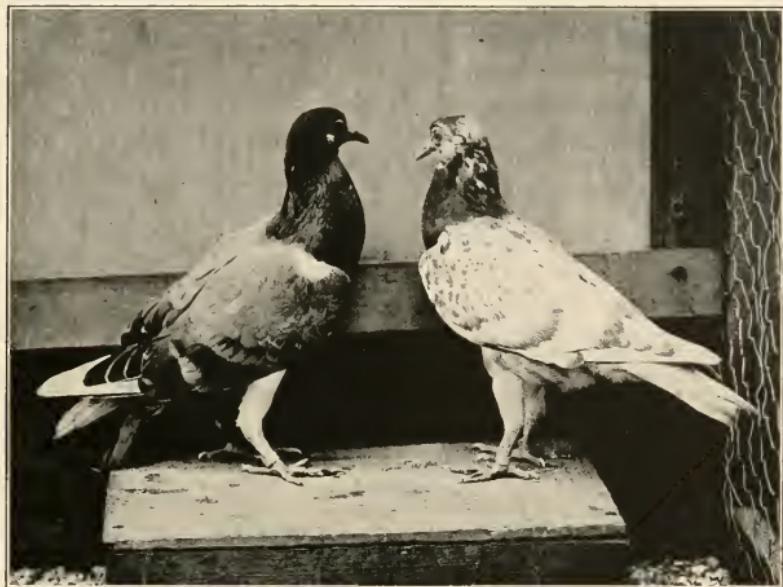
E 1 is at the extreme right. The color of this bird is rock-gray with two black bars.

E 2 is at the center. This bird is red throughout; there are no wing-bars, and the bases or proximal parts of the feathers are whitened.

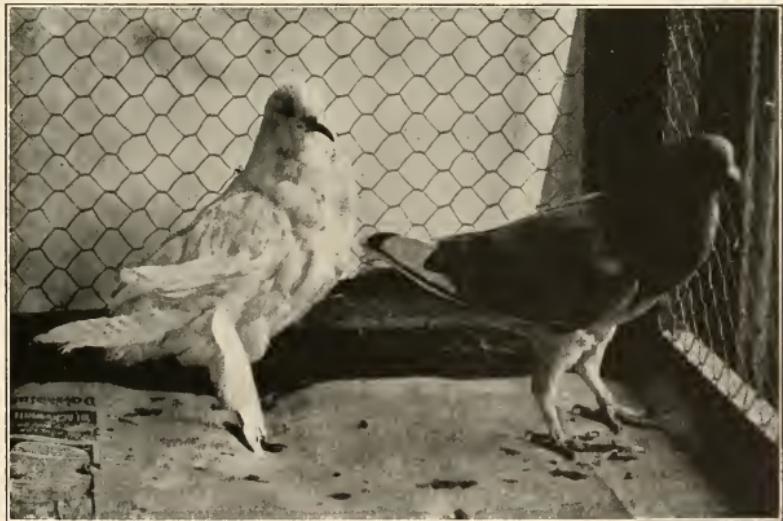
¹¹ Unfortunately the relative weights of these eggs is unknown; in many (or most ?) domestic pigeons the usual order (for wild species), for both size and prospective sex, is maintained quite loosely or not at all.—EDITOR.

¹² The numbers in the table are tag numbers given to the birds. The second bird hatched was given no number; therefore "ninth" and "tenth" above correspond to birds numbered (8) and (9).—EDITOR.

A

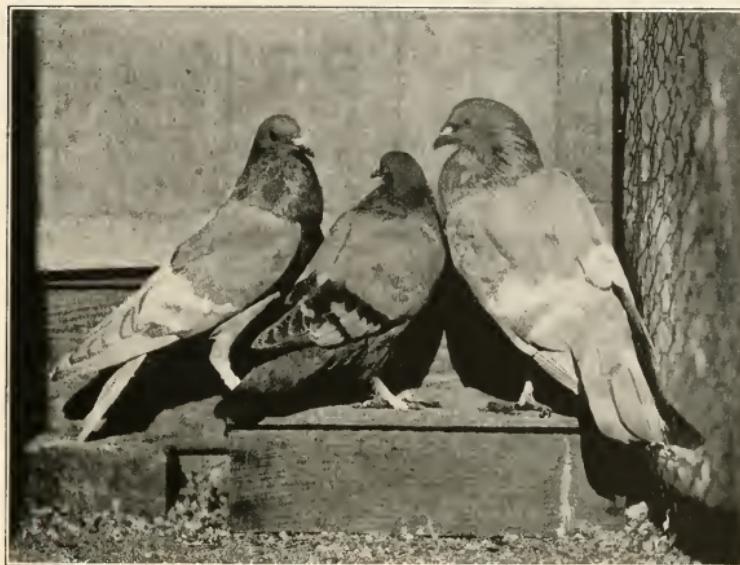


B

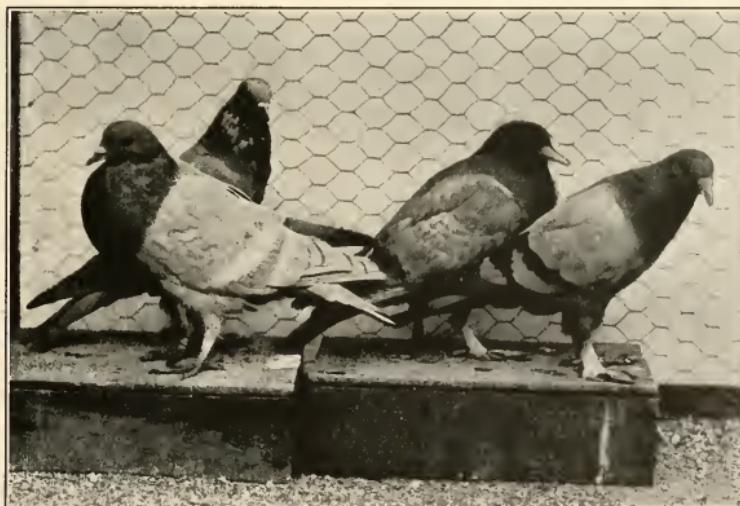


- A. Juvenile pair (*C 1* and *C 2*) of gray pouters from a brother-and-sister mating (pair 3 of table 80). Photographed at 7 weeks.
- B. Juvenile pair (Nos. 8 and 9) from gray, white-barred parents; 12 weeks old (see table 79).

A



B



- A. Adult gray pouters (son and dam, see table 79) and one of their offspring (*J*, of Aug. 5, 1909; see table 79) in juvenal plumage.
- B. Adult gray pouters (male No. 4 and female No. 6 of table 79), and two of their color-modified offspring (*E 1* and *E 2* of August 9 and 11, 1909; see table 80). Photographed Oct. 16, 1909; the young at 7 weeks old.

(9 in table) being practically pure white. These birds are shown in pls. 14 and 17. Another striking color variant of another type, from the following summer, when the dam was mated to a normal son, is shown in pl. 18. Two normally colored young, the fifth and seventh of the series of 1908, may be seen in pl. 18.

The first, ninth, and tenth of these young gave still other evidences of physical degeneracy. A mating of the first young of the series, a female gray pouter (1), with a male black pouter produced but a single pair of eggs (no record of hatching); three abortive attempts at egg-laying show, however, that this female, from the very first egg of the season, was a degenerate; the red bars of her adult plumage indicate the same.¹³ (G 16)

Two of the sisters of this bird, from very late in the season, were also degenerates. Concerning this pair the following statement is found:

"Degenerates ♀ 8 and ♀ 9: Female 8 was hatched October 10, 1908. She is dark gray, having bars *red* with *black* border. A neat bird but a degenerate as shown by color, and by her failure to produce an egg March 6, 1909, when mated with a strong male black pouter.

"Female 9 hatched October 11, 1908—*white!* Her feathers were slow and very irregular in growth; she was never able to fly, but lived until January 27, 1909. She was kept in the house and well cared for, and there was no cause for death but weakness. The legs of this bird sprawled, so that walking was difficult; her motions were very shaky, the head shaking like a fantail; the primaries hung loosely apart." (G 16, R 16)

These birds are shown in pl. 17.

Several other pouters of the same series (hatched in 1908) were mated brother-to-sister during the following year. The records of 3 such pairs is given in table 80. In 1909, pair 1 threw, from the last clutch of record, a bird with deficient pigmentation and "diverging legs." Two normal birds had preceded it. Only a single clutch of eggs was laid (March) during the following year. The bird from the first egg here had white wing-bars and was too lightly pigmented; that from the second egg had black bars with traces of red. Pairs 2 and 3 of these brother-to-sister matings each threw a solid red or red-orange bird as their final effort in the late season; in pair 3, which bred latest (until September), both eggs of the last clutch showed red, though one of these had red only in the region of the normally white bars (see pl. 14). An earlier clutch produced one bird of normal color, and one with nearly all feathers "white" with broad tips of "brown-orange." This bird also had "diverging legs." Both young from this clutch are shown in pl. 17. The abnormally colored young from the last eggs of pair 2 are shown in pl. 18. Besides the red-colored young mentioned above, another of the rock-dove type was produced from the first egg. The two strongly abnormal young of these two pairs were both from the second egg of the clutch.

The black Brünn pouters listed in table 81 show abnormal "gray" birds (with the white bars of the black parents replaced by the black bars) from both of the latest laid eggs. The 4 birds from the second year of this mating all seem to have had their white bars more or less replaced by red or black.

¹³ "These birds mated about February 1, 1909, and were given a separate cote. They copulated, built a nest, and, although laying no egg, began to sit on empty nest early in March. They were allowed to continue sitting, which they did for about 2 weeks. Later, after leaving the nest for about a week, they returned to it as if to begin a second turn. This time also no egg was laid, and the sitting continued for only about a week. A third attempt was made in April, but without an egg. About May 1 and 3 they began to build the same nest in the same place, and at length, on May 9, the female laid her first egg! As this female was hatched May 2, 1908, she should have succeeded in producing an egg early in the winter. To have failed several times, up to May 9, shows that she is a degenerate." (G 16)

COLOR IN OWL X ROCK CROSSES.

Three separate matings of African owls (*Columba turbata dom.* var.) with domestic rock-pigeons¹⁴ (*C. liria dom.*) seem to show that color is here sex-limited in its inheritance. The editor finds no comment on the data, which are presented in full (tables 82 to 83A). The reader will readily see, however, that young of two colors are produced and that all of the known females were of the light "owl" color, and that all known males were of dark color.

Two pairs of owl × rock hybrids were inbred. From pair 1, 3 red offspring were obtained in late season and "out of season" (table 84). This case further illustrates the point, elsewhere mentioned by the author, that a commingling of colors quite often produces red, though neither parent nor grandparent exhibited this color. The second pair was composed of the male of the preceding pair mated to his half-sister. Though this female showed traces of "brown" in the chequered parts of her wing, neither of the resulting 6 offspring was red. In this case also, however, the last clutch of the season produced two birds of the lightest color present in the series. It may be pointed out that there are three obvious reasons why one should expect fewer red offspring from pair 2 than from pair 1: (1) the degree of inbreeding is less; (2) the eggs were produced from a better part of the season; and (3) the mother of the female of pair 2 was darker than the mother of the dam used in pair 1. Females of dark and of light color appear in the F_2 generation.

FERTILITY AND SEASON IN CROSSES OF COMMON PIGEONS WITH FERAL COLUMBÆ.

A few data are available on the crosses of the stock-dove (*Columba ænas*) and the wood-pigeon (*Columba palumbus*) with domestic pigeons. In the single record for the stock × domestic cross a complete failure of fertility is found in the late autumn (table 85). The young produced from the stronger germs of the season nearly all died early, but this was the result of their feeding and is probably not otherwise significant. One of the male hybrids was fully fertile with *C. liria dom.*, and the author notes, of the last young of the season (table 86), that "color here seems to be that of the earlier hatched young."

A cross of *C. admista dom.* × *C. palumbus* proved remarkably infertile (table 87); but since only a single female was tested, this cross may be more fertile than is here indicated.

Two common pigeons obtained in the autumn of 1910 from a fancier yielded, during the autumn, but two clutches of eggs. Developmental power was then at a very low point, as is shown by the complete failure of the last clutch (October 7 and 9) to develop, and by the production from both eggs of the earlier clutch (September 17 and 19) of "two young with much white."¹⁵ The male was a brunette—quite black. The dam was red with white primaries and with the so-called "guinea-mark," i.e. a small triangular white tip to many of the feathers (G 9). The dates of the death of the parents, the male before February 15, 1911, and the female on August 18, 1911, is a further evidence of weakness in these birds at the time they gave rise to the "whitened" young.

¹⁴ It will at some time be of interest to note the order of the sexes from eggs of *C. liria dom.* Within the individual clutches of these birds the order of sexes from the eggs varies greatly from the order known for most pure wild species; the first egg here often gives rise to a female, the second often to a male; and studies by the editor have further shown that the size relations of the yolks of the two eggs of the *C. liria dom.* clutch are similarly variable.

¹⁵ These birds were photographed October 14, 1910, but copies or plates are not available to the editor.

BREEDING DATA ON WILD ROCK-PIGEONS.

Chiefly in the interest of a complete presentation of *all* of the breeding data for the common pigeons and the related (ancestral?) forms, tables 87A to 87D have been prepared.

Concerning a mating (table 87A) of a wild *C. livia* with a domestic pigeon of similar appearance (*C. livia dom.*) the author makes the following statement:

"I notice in rock-pigeon hybrids obtained by crossing a chequered male (*C. affinis*, from Inishbofin, Ireland) with a two-barred female (*C. livia*, from Dover, England) that the bars in the young are pale, especially the anterior bar. The same is true of these bars in the young (first feathers) of domestic pigeons. In the young of 'pure' rock-pigeons, however, the bars are both 'strong black.' Besides, the gray is pure in the pure-bred; that is to say, it is about the same as in the adults, while in these impure young rocks there is a decided brownish tinge in the gray."

"I infer that weak or pale bars in the first feathers is due to degeneration, the degeneration showing itself first in the juvenal feathers. It is certainly interesting that the pure-bred rocks strike so directly into the adult color."

For the matings of wild rock-pigeons, two-barred and chequered forms, the data of the tables (87B to 87D) are not very complete. The fact that these forms are usually considered to be the ancestors of the numerous races of fancy or domestic pigeons serves, however, to give some value to these records. It will be noted that the chequered rocks (*C. affinis*) obtained from the Cromarty Caves, Scotland, repeatedly threw typical offspring of the two-barred variety.

TABLE 70.

δ^3 Common pigeon (red guinea-chequers); from dealer 1906 (at about 1 yr. old); has some white primaries; frilled (see pl. 53, Vol. I, also pl. 14). [Vol. I, also pl. 14].

A 1. 7/2/08.....hatched.....dead 7/23/08; cause unknown.

A 2. 7/4/08.....hatched.....dead 7/23/08; cause unknown.

B. 8/1; some development, but unhatched.

δ^3 C 1. 9/22.....(1).....hatched; like sire, but more white.

C 2. 9/24.....(2).....about same amount of white as 1, but more dark gray where it is red-brown.

δ^3 D 1. 11/7.....(3).....hatched.....dead 1/20/09; "considerable white."¹

D 2. 11/9.....(4).....hatched.....dead 1/26/09; "considerable white."

δ^3 (E 1.) hatched 2/1/09-(5); dead 9/5/09; 1 primary white, mostly dark as dam.²

(E 2.) hatched 1/15/09-(6); no white in wings, mostly dark as dam.

F 1.) hatched 3/6; red; with white primaries like sire.

F 2.) hatched 3/7; killed; fell from nest.

G 1.) hatched 4/3.

H 1.; no record.

I 1; no record.

G 2.) hatched 4/3.

H 2; no record.

I 2; no record.

J 1.) hatched about 8/17; very light; "three-fourths, or more white" (see pl. 14).

J 2.) hatched about 8/19; very light; "three-fourths, or more white" (see pl. 14).

K 1. 6/7/10; color of black guinea mother.

δ^3 K 2. 6/7/10; red and white primaries, like sire.

(XG 26)

¹ "D 1 (3) at the age of 6½ weeks has white primaries and white secondaries in each wing. Body white above and below. Outer feather of each side of tail white in outer web, clear up to the (subterminal) bar; upper and lower tail-coverts gray anal feathers white. The wings are blackish (though the 'white apical guinea-marks' are generally increased) with red-brown visible everywhere. White flecks on the head and in the outer front edge of each wing; upper part of legs white; a large patch of white under the chin, wide above and narrowing to a rounded point on middle of lower breast. White is thus everywhere symmetrically distributed on the two sides of the body. *The birds from late in the season of 1908 all had much white!*"

² Only the date of hatching is known for these eggs.—EDITOR.

³ This bird used as sire in the mating fully described in the text, p. 95.—EDITOR.

TABLE 71.

σ^{α} C. tabellaris (Hom. 1); from fancier (2+ yrs.) 1897; killed (cats) 1902; fairly thickly chequered.	
♀ C. tabellaris (Hom. 3); stray 1898; lost 1902; thickly chequered.	
♀ A 1. 4/11/99; hatched } both chequered, but one more than the other.	
♀ A 2. 4/13/99; hatched }	
♂ B 1. 5/27; hatched, lighter than either parent; frills.	
B 2. 5/29; no development.	
C 1. 6/27; hatched, color?	E 1. 8/24; did not hatch.
C 2. 6/29; hatched, color?	E 2. 8/26; hatched; color?
♂ D 1. 7/26; black as sire.	F 1. 9/20 } one lost on trip.
♀ D 2. 7/28; blacker than sire.	F 2. 9/22 } one no development.
G 1. 10/16; hatched, black chequers a little blacker than sire; less than D 2.	
G 2. 10/18; hatched, black chequers a little blacker than sire; less than D 2.	
H 1. 11/19; hatched, a little blacker than sire.	
H 2. 11/21; hatched, a little blacker than sire.	
♂ I 1. 1/22/00; hatched chequered less than sire.	J 1. 3/7; did not hatch.
♀ I 2. 1/24/00; hatched chequered less than sire.	♀ J 2. 3/9; hatched, strongly chequered with black.
♂ K 1. 4/8; hatched darker than sire.	
♀ K 2. 4/10; hatched darker than K 1 = strongly and evenly chequered (see pl. 4, Vol. I).	
♂ M 1. 6/12; hatched, pure gray with 2 black bars.	L 1. 5/13; hatched (killed at once).
M 2. 6/14; hatched, more thickly chequered than sire.	L 2. 5/15; some development.
N 1. 7/15; hatched, more black than sire, left hind toe white (x = black).	
N 2. 7/17; hatched, as black as sire, a short white streak behind eyes.	
O 1. 8/20; hatched, no record of color.	
O 2. 8/22; hatched, no record of color.	
These birds were left at Woods Hole during the winter of 1900-01 in charge of Mr. Bernt Olsson, who raised several young without chequers, having only gray color with two black bars."	
P 1. 7/9/01 } no record kept during	Q 1. 12/9 }
P 2. 7/11/01 } summer 1901.	Q 2. 12/11 } one paler than the other.
A daughter; pale gray, no chequers (from early 1900); given (Hom. 1) 1/19/02.	
A 1. 2/6/02; shell rather soft.	B 1. 2/22 } one gray, no chequers; other chequered less
A 2. 2/8/02; shell not strong.	B 2. 2/24 } than sire.
C 1. 4/3; hatched, killed.	D 1. 7/1; no record.
C 2. 4/5; hatched, killed.	D 2. 7/3; no record.
	E 1. 9/29; hatched.
	E 2. 10/1; hatched.
	(BB 5)

TABLE 72.

σ^{α} C. tabellaris (K 1); brother; 4/8/00; strong black chequers.	
♀ C. tabellaris (J 2); sister; 3/9/00; strong black chequers (a white fleck over eye).	
♀ A 1. 10/26/00; hatched, less black than parents, touch of white behind each eye (dark streak in right iris).	
♂ A 2. 10/28/00; hatched, less black than parents, touch of white behind each eye (dark streak in left iris).	
♂ B 1. 12/28; hatched, dark chequered (nearly) as parents; traces white, asymmetrical upper mandible.	
♂ B 2. 12/30; hatched, dark chequered as parents; traces white and red.	
C 1. 2/20/01; broken.	D 1. 3/10/01; hatched; no record.
C 2. 2/22/01; broken.	D 2. 3/12/01; hatched; no record.
F. 1/13/02; hatched (very light complexion), dead at 5 days.	E 1. 4/8; hatched; no record.
G 1. 2/18; hatched; reddish-black chequers.	E 2. 4/10; hatched; no record.
G 2. 2/20; hatched; color of dam almost perfect even to the white spot over eye.	
H 1. 4/2 } one is like the dam; other is dark chequered, variegated with much white.	
H 2. 4/4 }	
I 1. 5/12; hatched; killed (presumably because neither very dark, nor peculiar).	
I 2. 5/14; hatched; killed (presumably because neither very dark, nor peculiar).	
J 1. 6/28; no record.	K 1. 2/1/03 } one hatched "dark as parents"; other prob-
J 2. 6/30; no record.	K 2. 2/3/03 } ably not hatched.
L 1. 3/9/03; removed.	M. 4/15; dark chequered as parents.
L 2. 3/11/03; removed.	N. 5/17; deserted.
♀ (O 1. 6/4 } one dark chequered as parents, and killed; other a ♀ (5) blackish-red chequered; freckled with white behind both eyes.	
♀ (O 2. 6/6 }	
♂ (P 1. 9/8 } one a ♂ (6) black red chequered; mated 1904	Q 1. 4/13/04 } one has dull red chequers; other is normal
♂ (P 2. 9/10 } with No. 5 above.	Q 2. 4/15/04 } color of female parent.
R. 1/24/05; hatched; soon died.	
S 1. 3/23 } both very light complexion; one died, other (S) has more strongly red chequers than any before it; also has	
S 2. 3/25 } white flecks on the head.	(BB 6)

TABLE 73.

♂ Homer (C 1); hatched 3/5/01; even gray; 2-barred ("double-nephew" to the mate).

♀ Homer (C) = (3); 3/15/01; 3d bar very obscure; chequers none on wing, few on scaps.

A 1. 3/14/02; probably not hatched.

A 2. 3/16/02; probably not hatched.

B 1. 4/11¹; both hatched, one was 2-barred and dark gray, other, very light or pale gray with two reddish bars.¹

B 2. 4/13¹

C. ?; hatched, pale with reddish bars.

D 1. 10/1; no record.

F 1. 3/26; no record.

H. 9/13; no record.

D 2. 10/3; no record.

F 2. 3/28; no record.

E 1. 2/14/03; hatched; no record.

G 1. 7/4; no record.

I. 5/15/04; no record.

E 2. 2/16/03; failed.

G 2. 7/6; no record.

(BB 9)

¹ "The imprints of some chequers for a third bar were present as a tinge of reddish."

TABLE 74.

♂ C. tabellaris (6); brother; 9/8/03; 8/3/06; black-red chequers.

♀ C. tabellaris (5); sister; 6/5/03; blackish red chequers.

A 1. 4/12/04; removed.

D 1. ? no development.

G 1. ? no development.

A 2. 4/14/04; removed.

D 2. ? no development.

G 2. ? no development.

B 1. 5/15; no development.

E 1. ? no development.

H 1. ? no development.

B 2. 5/17; no development.

E 2. ? no development.

H 2. ? no development.

C 1. 7/6; probably no development.

F 1. ? no development.

I 1. ? no development.

C 2. 7/8; probably no development.

F 2. ? no development.

I 2. ? no development.

D 1. 1/25/05¹; one hatched; dead (care) few days; other

E 1. 3/5; a little development.

D 2. 2/27/05¹; egg failed.

E 2. 3/7; a little development.

F 1. 4/4; not tested.

H 1. 5/30; no development.

F 2. 4/6; not tested.

H 2. 6/1; no development.

G 1. 5/1; no development.

I 1. 7/24¹; few days development, in one, or both.

G 2. 5/3; no development.

I 2. 7/26¹; few days development, in one, or both.

J. 1/7/06; bird hatched, but "suspected another male had fertilized this egg."

K 1. no development.

K 2. no development.

(BB 7)

TABLE 75.

♂ C. tabellaris (1907); 3-barred, trace chequers on scapulars, same as sire.

♀ C. tabellaris (from fancier 1907); 2-barred, true rock type; dead 5/??/00.

♀ (A 1. 12/10/07)¹ hatched; one killed;¹ other a pale ♀ 3 bars; weak chequers.
 (A 2. 12/12/07)

B 1. 5/12/08; hatched; color like sire.

B 2. 5/14/08; hatched; color like dam.

C 1. 6/15/08; hatched¹; about color of old birds, killed.

C 2. 6/17/08; hatched¹; about color of old birds, killed.

D 1. 9/5; hatched; "not peculiar"; killed

D 2. 9/7; hatched; "not peculiar"; killed

♀ E 1. 10/28; light gray; 2 narrow bars, a trace of third; obscure chequers on scap's; frills (see pl. 71, Vol. I).

♀ E 2. 10/30; trace darker than E 1; 2 bars, no trace of third; no chequers.

♀ F. 2/2/09; hatched; very light gray; 2 extremely narrow bars.

♂ G 1. 3/23; hatched; rock-gray; 2 bars, narrowed.

♀ G 2. 3/25; hatched; rock-gray; 2 bars, about normal.²

Above ♀ disappeared, and ♀ F (2/2/09 above) mated to sire;³ very narrow bars.

♂ H 1. 8/10/09; hatched; very light; 2 bars with most black washed out; breast frill.

♀ H 2. 8/12/09; hatched; clear rock-gray; 2 narrow bars.

♂ I 1. 11/15; hatched; rock-gray; only 4 spots of posterior bar, anterior bar absent (see pl. 16), except few "freckles"; frilled

♀ I 2. 11/17; hatched; almost white⁴ or silver gray; 2 weak bars (see pl. 16); frilled.

J 1. 1/7/10; no development.

J 2. 1/9/10; no development.

♂ K. 2/5; hatched; dark gray tinged with brown; bars weak.

♂ L 1. 2/13; very dark gray like K; bars obscure.

♀ L 2. 2/15; color light; narrow bars, these disappearing in lower half.

(G 12)

¹ The original purpose of this breeding was to get progeny of "two bars" or less (without chequers). The birds that gave little promise of leading in this direction were usually killed as soon as they came to full plumage.—EDITOR.

² Thus from E to G we have had only 2-barred young, with bars sometimes much below the normal width and density." (G 12)

³ This female was barely 5 months old and mated at once. From this inbreeding I hope to see the bars further reduced."

⁴ It is notable that this female was fertile—at least 1 egg of 2 laid—when mated with her clutch-mate brother (I 1); there is no record of this offspring after hatching and it probably died before old enough to disclose its color. It seems probable, too, that this single clutch was all that was produced in 1910.—EDITOR.

TABLE 76.

σ^a C. tabellaris (H 4) (stray, 1900); 2 bars + trace of third bar, and chequers (see pl. 4, Vol. I).
 φ C. tabellaris (K 2); 4/10/00; 3 bars + chequers; quite dark gray (see pl. 4, Vol. I).

A 1. 11/28/00; no development.	
A 2. 11/30/00; no development.	
σ^a and φ B 1. 1/25/01 { one, a φ pale gray, 3 bars, a fourth of only 3 spots (<i>intermediate</i>); slightly darker than sire; other B 2. 1/27/01 } a σ^a medium dark gray; darker than dam (<i>i.e.</i> , darker parent).	
φ C 1. 3/12 { one a φ (3) dark gray like dam but fewer chequers (<i>intermediate</i>); other 3 bars but no chequers, C 2. 3/14 } nearer sire (<i>intermediate</i>).	
D 1. 4/17; hatched, no record.	
D 2. 4/19; hatched, no record.	
E 1. 5/25 { both young about midway between parents (<i>intermediate</i>); E 2. 5/27 } but one perceptibly paler than the other (<i>intermediate</i>).	
F 1. 7/20; no record.	G 1. 1/18/02; broken.
F 2. 7/22; no record.	G 2. 1/20/02; broken.
H 1. 2/12/02; more chequered than sire, less than dam (<i>intermediate</i>).	
H 2. 2/14/02; more chequered than sire, less than dam (<i>intermediate</i>).	
I 1. 4/1; hatched; apparently not notable; killed.	
I 2. 4/3; hatched; apparently not notable; killed.	
J 1. 7/1; no record.	K 1. 8/4 (?) hatched; medium chequered (<i>intermediate</i>).
J 2. 7/3; no record.	K 2. 8/6 (?) hatched; medium chequered (<i>intermediate</i>).
L 1. 10/29; hatched; plain gray with 2 narrow bars } one dead 2/14/03; other dead 3/13/03.	
L 2. 10/31; hatched; plain gray with 2 narrow bars }	
M 1. 12/7; failed to hatch.	
M 2. 12/7; failed to hatch.	
N 1. 2/12/03 } one has chequers same as female parent, other has no chequers, and only 2 narrow bars.	
N 2. 2/14/03 }	
O 1. 3/30; chequered about as strongly as dam.	
O 2. 4/1; plain light gray; chequers reduced.	
P 1. 5/6 } one chequered, other only 2 bars.	Q 1. 7/6; no record.
P 2. 5/8 }	Q 2. 7/8; no record.
	R 1. 9/12; no record.

σ^a S 1. 4/14/04 (7); chequered more than sire (*intermediate*) (see pl. 5, Vol. I).

φ S 2. 4/16/04 (8); pale; bars pale, and third bar weak¹ (see pl. 5, Vol. I).

T 1. 5/11. U 1; 5/26; not tested.
T 2. 5/13. U 2; 5/28; not tested.

V 1. 7/9 } one color of S 1 (*intermediate*), other very
V 2. 7/11 } pale 2 bars, no chequers.² (BB 4)

[W 1. 1/6/05; hatched; no record.

X 1. 3/3; color intermediate.

W 2. 1/8/05; hatched; no record.

X 2. 3/5; color very pale (bars not described).

Y 1. 4/15/05; complexion very light (apparently died early) in one; other, if hatched, died early and thrown from

Y 2. 4/17/05 } nest by parents.

Z. 5/25; no record.

nest by parents.

¹ It is noted that the two birds of this clutch were mated Dec. 1904, but I have been unable to find the data.—EDITOR.

² It is noted at this point that "so far 5 young with only 2 bars and pale gray; nearly all the rest are less chequered than the dam."

TABLE 77.

σ^a Black barb; from dealer; 2/1/01.

φ Black barb; from dealer; 2/1/01 dead; winter 1901-02

A 1. 2/11/01; broken.

D 1. 5/24; (black if hatched).

A 2. 2/13/01; developed, but broken.

D 2. 5/26; (black if hatched).

B 1. 3/5; no development.

E 1. 7/13; hatched; black.

B 2. 3/7; no development.

E 2. 7/15; hatched; black.

C 1. 4/15; hatched; black.

C 2. 4/17; hatched; black.

Daughter of above σ^a given (=black of 1901). This *inbreeding* gave:

A. 2/7/02; no development.

C 1. 4/9; probably did not hatch.

B 1. 3/3; hatched; dead 7 to 10 days.

C 2. 4/11; probably did not hatch.

B 2. 3/5; hatched; dead 7 to 10 days.

D 1. 2/11/03; black } one died few days, other 8 weeks.

φ { G 1. 7/5 } one red φ , other black (soon died).
D 2. 2/13/03; black }

E 1. 3/24 } one black, other gray.

σ^a and φ { H 1. 9/12; red } one died 2 to 5 mo.; other (σ^a);

E 2. 3/26 }

H 2. 9/14; red } alive 1904.

σ^a F 1. 5/9; red. (1)

F 2. 5/11; not hatched.

TABLE 77 (*continued*).

I 1. 4/20/04; black.	K 1. 7/?
I 2. 4/22/04; black.	K 2. 7/?
J 1. ? — ?	L 1. 9/?
J 2. ? — ?	L 2. 9/?

(? Other eggs probably laid; not recorded.)

J 1. 1/1/05	one black, died early; other red, died 1 mo.	M. 4. 28; no record.
J 2. 1/3/05		N 1, N 2, probably not recorded.
♂ [K 1. 2/12] [K 2. 2/14]	one red ♂, alive 1909; other not hatched.	O 1. 8/13; black.
L 1. 3/24 L 2. 3/26	one black, dead (lice) at 2 weeks; other un-hatched.	O 2. 8/15; red (killed by lice).

This ♀ became tubercular, produced no eggs in 1906; was killed.

There is no record of barbs produced in 1907. In 1908 this male was mated to another daughter—black—(of 1905?). A few eggs probably laid, without record until May.

♀ A 1. 5/13/08; gray; ¹ dead 12/19/08.	
♀ A 2. 5/15/08; gray; dead (?) 4/24/12 (mated w. brother 1909).	(BB 3)

¹ At this point in the breeding of these black barbs it is remarked that "this is an interesting case, as the color runs from black to red and to gray; black being most frequent, red occasional, and gray very rare." Black color predominates, and most pronouncedly so at the season of strongest germs (spring) and in the kind of matings (unrelated, or mature parentage) elsewhere found to be productive of strong progeny.—EDITOR.

TABLE 78.—*Brother-sister matings of black barbs.*

♂ Black barb; (1903–1905); brother; black color.
♀ Black barb; (1903–1905); sister; black color.

Early 1908, probably one or more clutches before:

?	7/17/08	one black, other gray; both dead autumn 1908.
?	7/19/08	

A 1. 2/27/09; hatched; black.	B 1. 4/18; no record.
A 2. 3/1/09; hatched; black.	B 2. 4/20; no record.

♂ Black barb; brother or half-brother to mate (A 2).

♀ Black barb; of gray color; (A 2); 5/15/08.

A 1. 3/28/09; hatched; black; dead (care ?), tuberculosis, after 15 days.

A 2. 3/30/09; did not hatch.

B 1. 4/27; probably no development.

B 2. 4/29; probably no development.

♂ Red barb (K, alive 1909) mated to ♀ red and white Jacobin produced:

♀ [A 1. 2/18/06] [A 2. 2/20/06]	one hatched; blackish, with little red; other no data.

B 1. 3/19; hatched; dusky brown.	C 1. 5/16; blackish and chequered.
B 2. 3/21; hatched; pale red.	C 2. 5/18; hatched, red.

(BB 3)

TABLE 79.

Pair A.

♂ Gray Brünn pouter; from fancier; 2/17/08; gray with white bars edged w. black.

♀ Gray Brünn pouter; from fancier; 2/17/08; gray with white bars edged w. black.

♀ A 1. 4/12/08	1.....gray; juvenal bars black, adult red with black borders.
A 2. 4/14/08; dead at 2 weeks.	

♂ B 1. 5/16.....	2.....gray impure with black; juvenal bars purer white than in parents.
♀ B 2. 5/18.....	3.....gray; with white bars.

Pair B.

♂ Parent died 6/4. A second male, like first in color, given about 6/15 '08.

♂ A 1. 6/28/08.....4.....	color of parents; alive 10/14/09 (see pl. 18).
A 2. 6/30/08.....5.....	nearly naked at hatching; very small; dead 7/23/08.

♀ B 1. 8/1.....6.....	color of parents, alive 10/14/09 (see pl. 18).
♂ B 2. 8/3.....7.....	color dark gray with red bars ¹ (see pl. 14).

♀ C 1. 9/22.....8.....	dark gray; juvenal bars red-black, but in adult turned to white with black border (see pl. 14, ad.; pl. 17, <i>juvenal</i>) dead 9/1/09.
♀ C 2. 9/24.....9.....	white; ² long unable to fly, dead 1/27/09, good care (see pl. 17).

D 1. 11/5.....10.....	color of parents.
D 2. 11/7.....11.....	6 right outer flights "white"; 5 left outer flights "white"; dead 12/28/08 (care).

E 1. and E 2; 12/18 to 20; deserted.

F 1. 1/26/09; hatched; no later record.	
F 2. 1/28/09; failed.	

TABLE 79 (*continued*).*Pair C.*

♂ Parent died 2/7/09. One (not recorded which) of the sons from 1908 then put here with dam; his color was normal (see pl. 18).

G 1. 3/31/09; no record.

G 2. 4/2/09; no record.

J. 7/18.....hatched.....11.....color gray rock, 2 black bars (see pl. 18).

K. 11/8.....hatched.....12.....adult color like parents pale gray, white bars.

H 1. No record.

H 2. No record.

I 1. No record.

I 2. No record.

¹ "The 'red' in the juvenile feathers is about the same as the red in the adult feathers of No. 1 above; i.e., this bird is a step higher in evolution than No. 1 was. The adult bars in No. 7 are red with black borders."

² "The juvenile white pouter (9) came at the *end of the season* (see record) and the dark gray pouters with red bars (black-edged) came later in season, and so far (Mar. 29) these birds, although mated, and making nests and sitting, have produced no eggs." (R 16)

TABLE 80 — *Gray Brünn pouters in brother-sister matings.**Pair 1.*

♂ 2; two white bars edged with black, body gray, "sprinkled with black."

♀ 3; two white bars edged with black, body gray without black.

"Previous to July 1909 this pair raised 3 young; 2 were like the parents and a third resembles the others, but was hatched about June 25, and is weak in some respects. Among other things, the legs diverge a little more than they should, and the 'fundamental barring'³ is apparent through failure of the normal production of pigment. The fundamental bars have here wrought conspicuous effects upon the tail, flights, tail coverts, secondaries, and other parts." This bird seems to have been the last bird produced in 1909. The record for 1910 is also complete with the following pair of eggs.—EDITOR.

♀ C 1. 3/14/10; hatched; juvenile light gray, 2 white bars (and fundamental bars).

♀ C 2. 3/16/10; hatched; juvenile color dark gray, 2 black bars, with trace of red.

Pair 2.

♂ 4; gray², with white bars edged with black.

♀ 6; gray, with white bars edged with black.

A 1. 2/3/09; no test.

A 2. 2/5/09; no test.

E 1. 8/9; hatched; rock gray, with black bars (see pl. 18).

B 1. 3/10; killed.

B 2. 3/12; killed.

E 2. 8/11; hatched; color red throughout (see pl. 18).

C 1. 4/15; no record.

C 2. 4/17; no record.

D 1. no record.

D 2. no record.

Pair 3.

♂ 7; dark gray; bars red with black borders.

♀ 8; dark gray; bars white with black borders.

A 1. ?/09; failed to hatch.

A 2. 7/09; failed to hatch.

B 1. 4/1; hatched; no record.

B 2. 4/3; hatched; no record.

♀ C 1. 5/10; hatched; color of parents, dead 9/1/09 (see pl. 17).

♂ C 2. 5/12; only white and brown orange; legs diverge; dead 2/12/10 (see pl. 17); frills.

D 1. 7/6; no record.

D 2. 7/8; no record.

♂ E 1. 8/21; hatched; color rock gray, with red-orange bars.

E 2. 8/23; hatched; color red-orange throughout, basal parts of feathers white, no bars (see pl. 14). (G 16, G 15)

¹ For the explanation of this barring see Chap. VIII, Vol. I, of these works and Riddle, Biol. Bull. 1908.—EDITOR.

² "This male is not pure rock-gray; there are touches of blackish on the wing coverts."

TABLE 81.

♂ Black Brünn pouter; with 2 white bars (from fancier).

♀ Black Brünn pouter; with 2 white bars (from fancier).

A 1. 3/29/08.....1.....no record of color or death. B 1. 6/4.....3.....no record of color.
♂ A 2. 3/31/08.....2.....color of parents. B 2. 6/6.....4.....no record of color

♀ C 1. 8/17.....5.....gray with 2 bars black; alive 4/10/09.¹

♂ C 2. 8/19.....gray with 2 bars black; died before 4/10/09.

A 1. 4/12/09.....6....."guinea marks"; white bars partially replaced by red and black.²

♀ A 2. 4/14/09.....7.....anterior bar black,³ posterior bar partially replaced by red and black.

♂ 1. 7/13.....8....."guinea marks"; 2 bars different.

♀ 2. 7/15.....9.....anterior bar, black,³ posterior bar mostly black. (G 16)

¹ "A pair of young hatched in September 1908 were both gray with two bars black. One of these died, sex not noted. The other now alive (4/10/09) is a female (?) and mated with a black barb of 1909." In view of this statement it seems probable that the colors of Nos. 1, 3, and 4 were, in most cases at least, normal.—EDITOR.

² No. 6 died at 4½ months; No. 7 at 10 weeks (white).

³ Black bars in the *black* offspring means that the bars scarcely exist as differentiations in the coloration of the wing.—EDITOR.

TABLE 82.

Pair 1.

σ^3 Owl (I-C 2); hatched 5/4/00, with a frill.
 φ Rock (RK 1); pale gray; small, no frill.

♀ A 1. 10/15/00	..... disappeared 3/3/01	color owl-like; no frill.
♂ A 2. 10/17/00	.....	color dark rock; no chequers.
♀ B 1. 11/26	..... dead 3/24/02 (16 mo.)	color owl-like; no chequers, no frills.
♂ B 2. 11/28	..... killed 3/7/02	color dark rock; no chequers. ¹
C 1. 1/28/01	..... failed to hatch.	
♀ C 2. 1/30/01	.....	color pale, owl-like; no frills, no chequers.
D 1. 3/11; accident.		
♂ D 2. 3/13	..... dead 3/19/02 (12 $\frac{1}{4}$ mo.)	color dark rock.
E 1. 4/17	.....	color dark rock.
E 2. 4/19	.....	color gray rock.
G 1. 7/9	.....	color owl-like.
♂ G 2. 7/11	..... 4/12/02 (9 mo.)	color dark rock.
H 1. 8/10	.....	color dark rock; no frills. ²
H 2. 8/12	.....	color dark rock; no frills.

(G 17)

¹ The two birds from this clutch mated, 1901-2; see table 84.² The owl (*C. turbata*) has a tuft or frill at the breast (see text-figs. 28, 29, Vol. I).

TABLE 83.

Pair 2.

σ^3 Owl; age unknown.
 φ Rock (RK 2); large; gray color.

♀ A 1. 1/19/01	..... dead 5/10/02 (confinement ?)	color owl-like; very light gray.
♂ A 2. 1/21/01	..... dead 12/29/01	color dark gray; no chequers.
♂ B 1. 3/8	..... dead 4/20/02	color dark gray.
B 2. 3/10	..... crushed hatching	color owl-like.
♀ C 1. 4/17	..... 4/2/02	color owl-like.
C 2. 4/19	.....	color owl-like.
♀ (D 1. 5/27) (D 2. 5/29)	..... ♀ dead 4/22/02; 1 owl-like; 1 dark color.	
E 1. 7/14	.....	color pale owl-like.
E 2. 7/16	.....	color dark gray.

(G 17)

TABLE 83A.

Pair 3.

σ^3 Owl I-CI; hatched 5/4/00.
 φ Rock-RK 3; black chequered; thickly chequered.

σ^3 and ♀ A 1. 10/31/00	one is a ♀ owl-like (light gray) but with an even brown chequering, instead of black chequering; A 2. 11/2/00	alive 1/15/02. Other is a ♂; dead (cold) 12/22/00; dark rock, strongly chequered.
♂ B 1. 12/23	..... dead 7/12/02 (cholera ?)	color dark rock, strong chequers.
♂ B 2. 12/25	..... dead 7/12/02 (cholera ?)	color dark rock, strong chequers.
♀ C 1. 1/19/01	.....	color owl-like, pale chequers.
C 2. 1/21/01	.....	color rock-like, dark chequers.
D 1. 3/3	.....	color rock-like, dark chequered.
D 2. 3/5	.....	color owl-like, pale chequers.
E 1. 4/6; some development.	.....	color dark rock, dark chequers.
E 2. 4/7	.....	color dark rock, dark chequers.
♂ G 1. 7/22	..... dead 7/12/02 (cholera)	color dark rock, dark chequers.
G 2. 7/24	.....	color owl-like, pale chequers.
I 1. 3/23	..... one hatched, owl-like; pale chequers; other, no record.	
I 2. 3/25	.....
K 1. 7/2	.....	color owl-like, pale chequers.
K 2. 7/4	.....	color owl-like, pale chequers.
L 1. 8/6	.....	color dark chequers.
L 2. 8/8	.....	color dark chequers.
M 1. 9/27	..... one of dark color and one of light color.	
M 2. 9/29	.....

(G 17)

TABLE 84.—*Inbreeding of owl-rock hybrids.**Pair 1 (brother and sister).*

σ^3 Owl-rock hyb. (B 2); (11/28/00); 3/24/02; dark gray; no chequers.
 φ Owl-rock hyb. (B 1); (11/26/00); 3/7/02 (killed); owl-like; no chequers.

A 1. 5/2/01.	.....	hatched, no record for color.
A 2. 5/4/01.	.....	probably hatched.
B. 6/1.	.....	hatched..... pale, owl-like.
σ^3 C 1. 7/14.	.....	hatched..... dead 1/20/02; dark gray rock.
C 2. 7/16.	.....	hatched..... killed 12/7/02; pale reddish.
D 1. 2/6/02.	.....	hatched..... red.
D 2. 2/8/02.	.....	hatched..... red.

Pair 2 (half-brother and half-sister).

A second female hybrid from owl (1-C 2) \times rock (RK 3) black chequered given 5/10/02. This female (A 1) from egg 11. 1/00 (alive 1. 15. 02) was of pale gray color, but with pale to brownish chequers. Six birds from this female and the above male gave no red offspring.

A 1. 4/19/01.	.....	hatched..... dead at 7 days, "whole appearance owl-like."
φ A 2. 4/21/01.	.....	hatched..... matured and mated, "like sire in color and size."
B 1. 5/23.	.....	hatched..... dark gray, 2 black bars.
B 2. 5/25.	.....	hatched..... light gray, 2 bars owl-like.
C 1. 7/8.	.....	hatched..... pale owl-like.
φ C 2. 7/10.	.....	hatched..... dead 4/8/02; pale owl-like.

(G 2)

TABLE 85.

 σ^3 C. *oenas*; 3/16/09. φ C. *livia domestica*; 2-barred, rather dark gray.

A 1. 5/5/08.	.....	S-R 1. dead 7/13/08.
A 2. 5/7/08;	no development.	
σ^3 B 1. 5/28.	.....	S-R 2. dead 6/20/08 (feeding?).
σ^3 B 2. 5/30.	.....	S-R 3. dead 6/21/08 (feeding?).
σ^3 C 1. 6/27.	.....	S-R 4. dead at 7 days (feeding).
C 2. 6/29;	no development.	
σ^3 D. 7/11.	.....	S-R 5. dead 7/2/09 (fertile with <i>domestica</i>).
E 1. 7/31.	.....	S-R 6. dead 8/24/08 (overfeeding).
φ E 2. 8/2.	.....	S-R 7. dead 8/23/08 (overfeeding). ¹
F 1. 9/2;	no development.	
F 2. 9/4;	no development.	
G 1. 9/13;	no development.	
G 2. 9/15;	no development.	
H 1. 2/14/09.	.....	hatched; dead at 6 days (care?).
H 2. 2/16/09.	.....	hatched; dead at 6 days (care?).

(P 6)

¹ "I noticed on August 22 that seed (millet) passed through the young undigested; the trouble is 'too much food.' It is necessary not only to use fine seed, but also to be very careful not to overfeed during the first week or two weeks. One must keep constant watch of the droppings and cut off the seed if it passes undigested. Some soft food (bread-crumbs), cuttle-fish bone, oyster-shell, charcoal, plenty of sand-grit, and some lettuce seem advisable or necessary."

TABLE 86.

 σ^3 *Oenas* \times *livia domestica* (S-R 5); 7/11/08; 7/2/09. φ C. *livia domestica*; (from dealer 1909).

A 1. 3/21/09.	.....	SR-R 1. dead 4/23/09. ¹	B 1. 4/24.	.....	SR-R 3. dead 5/23/09.
A 2. 3/23/09.	.....	SR-R 2. dead 4/20/09.	B 2. 4/26.	.....	SR-R 4. dead 5/25/09.
C 1. 5/29.	.....	SR-R 5. dead 6/25/09; some unknown cause.			
C 2. 5/31.	.....	SR-R 6. dead 6/25/09; digestive trouble.			
σ^3 parent (S-R 5) died 7/2/09.					
D 1. 7/4.	.....	SR-R 7. probably died autumn 1909; certainly before 12/30/10.			
D 2. 7/6.	.....	SR-R 8. dead 7/31/09. ²			

(P 6, P 7)

¹ Neglect was cause of death.² "Color here seems to be that of the earlier hatched young." (P 7)

TABLE 87.

σ^3 C. <i>admista</i> (Z); 1894 or 1895; escaped 12/22/00.		
φ C. <i>palumbus</i> (Cp); 10/5/02.		
A 1. 6/26/99; no development.	E 1. 11/2; probably no development.	I 1. 6/7; no development.
A 2. 6/28/99; no development.	E 2. 11/4; probably no development.	I 2. 6/9; hatched; dead at 4 days.
B 1. 7/3; not hatched.	F. 1/28/00; broken. ¹	J 1. 7/12; no development.
B 2. 7/5; not hatched.		J 2. 7/14; some development.
C 1. 7/23; one egg, some development.	G 1. 3/30/00; no development.	K 1. 8/1; probably no development.
C 2. 7/25;	G 2. 4/1/00; no development.	K 2. 8/3; probably no development.
D 1. 8/10; no development.	H. 4/27; no development.	L 1. 8/30; probably no development. ²
D 2. 8/12; no development.		L 2. 9/1; probably no development.
		(F 29)

¹ Laying at this season and to the extent here noted "is an interesting proof of the effect of domestication on the productivity of the wood-pigeon." (F 29)

² Later the female of the above record was mated to another common pigeon (*admista*?). A single young was hatched (6/3/02). It seems to have lived only 7 days. (A 14, A 1/7)

TABLE 87A.—*Wild C. livia* \times *C. livia domestica*.

σ^3 C. <i>livia</i> ; from Inishbofin.		
φ C. <i>livia domestica</i> ; from fancier 1907; typical 2-barred in appearance.		
A 1. 4/18/08; hatched.	B 1. 6/9*; 20.	C 1. 7/15*; hatched; 22.
A 2. 4/20/08; hatched.	B 2. 6/9*; 21.	C 2. 7/15*; hatched; 23.
φ C. <i>livia domestica</i> (from fancier 12/27/08); 2-barred; trace of brownish in light blue gray. This φ has 13 tail feathers.		

A 1. 1/20; failed (poor incubation).

A 2. 1/22; failed (poor incubation).

C 1. 3/23; I-Kr 3.

C 2. 3/25; probably did not hatch.

σ^3 B 1. 3/1*; I-Kr 1; 3d vestigial bar; dead 4/28/08.

B 2. 3/2*; I-Kr 2; trace darker or browner than B 1.

(XS 2)

* Indicates date of hatching.

TABLE 87B.

σ^3 C. <i>livia</i> (2); from Inishbofin, 1901; dead 10/15/02.		
φ C. <i>livia</i> (2); from Inishbofin, 1901; accident 1/13/04.		
A 1. 3/8/02. 5.	σ^3 B 1. 4/23. 6.	
A 2. 3/10/02. 5. dead 9/18/02.	φ B 2. 4/25. 6. dead 10/9/02.	
σ^3 C. <i>affinis</i> (3); from Inishbofin, 1901.		
φ C. <i>livia</i> (3); from Dover, England, 1898.		
A 1. 1/7/02; one died at 1 week, other 2/26/02.	C 1. 3/1; one 3 C; other dead at 1 week.	
A 2. 1/9/02	C 2. 3/3	
B 1. 2/14; broken.	φ D. 4/15; 3 D; 2-barred; bars pale; ¹ dead 7/10/02.	
B 2. 2/16. 3 B. typical 2-barred.	E. 5/29; no record.	
σ^3 C. <i>livia</i> (number not certain).		
φ C. <i>livia</i> (number not certain).		
A 1. 12/14/02; failed (care).	D 1. 3/1. 7. dead 8/17/03.	
A 2. 12/16/02; failed (care).	D 2. 3/3. 7. alive 1905.	
B 1. 1/14/03; broken.	φ E 1. 4/23. 8. dead 3/10/05.	
B 2. 1/16/03; broken.	E 2. 4/25. 8. accident 5/13/03.	
C 1. 2/3; no record.	F 1. 7/8 (hatched).	
C 2. 2/5; no record.	F 2. 7/10 (hatched).	
σ^3 C. <i>livia</i> (0); from Inishbofin, 1901; dead 11/29/05.		
φ C. <i>livia</i> ; (earlier mated with owl).		
σ^3 A 1. 3/19/05. R 10. dead 7/29/06.	D 1. 7/6. R 14.	
σ^3 A 2. 3/21/05. R 11. dead 7/25/06.	D 2. 7/8; broken.	
B 1. 4/25. R 12. escaped at few weeks.	σ^3 E 1. 7/23/05. R 15. dead 7/15/06.	
B 2. 4/27. R 13. escaped at few weeks.	φ E 2. 7/25/05. dead 10/2/05.	
C 1. 6/1. hatched; killed at 3 weeks.	σ^3 F 1. 9/15/05. R 16. dead 7/16/06.	
C 2. 6/3. hatched; killed at 3 weeks.	F 2. 9/17; no record.	

¹ According to a statement in the text, "pale bars" were apparently the rule in these hybrids.—EDITOR

TABLE 87C.

δ^3 C. affinis (3); from Cromarty Caves, Scotland, 1908.	
φ C. affinis (2); from Cromarty Caves, Scotland, 1908; dead 5/3/10.	
♀ and ♂ (A 1. 3/10/09*.... CC 1..... moderately chequered.....	alive 2/7/11.
(A 2. 3/10/09*.... CC 2 ♀..... fully chequered.....	dead 6/30/13.
♂ B 1. 3/27..... CC 3..... typical 2-barred rock !.....	dead 12/3/12. C 1. 6/2; poor incubation.
♂ B 2. 3/29..... CC 4..... typical 2-barred rock !.....	alive 2/7/11. C 2. 6/4; poor incubation.
D 1. 6/20..... CC 7..... chequered nearly as parents.....	dead 10/2/09.
D 2. 6/22..... CC 8..... chequered nearly as parents.....	dead 12/6/09.
♀ E 1. 9/1*.... CC 9..... chequered nearly as parents.....	dead 12/16/09.
E 2. 9/2*.... CC 10..... typical 2-barred rock !.....	dead 1/12/10.

 δ^3 C. affinis (1). φ C. livia (3); killed 5/3/10.

δ^3 A 1. (3/12/09*.... CCB 1..... fully chequered; very small testes; dead 6/21/13.	
δ^3 A 2. (3/12/09*.... CCB 2..... typical 2-barred.....	dead 5/12/11.
♂ B 1. 4/5..... CCB 3..... typical 2-barred.....	alive 2/7/11.
♂ B 2. 4/7..... CCB 4..... chequered.....	dead before 2/7/11.
♂ C 1. 5/10..... CCB 5..... typical 2-barred.....	dead 5/3/10.
♀ C 2. 5/12..... CCB 6..... typical 2-barred.....	dead 1/28/11.
D 1. 7/25*.... CCB 11..... typical 2-barred.....	alive 1912.
♀ D 2. 7/25*.... CCB 12..... typical 2-barred.....	dead before 2/7/11.

 δ^3 C. livia (1); from Cromarty Caves, Scotland, 1908. φ C. livia (2); from Cromarty Caves, Scotland, 1908.

δ^3 and φ (A 1.) (3/31/09*.... C-B 1 δ^3 typical 2-barred.....	dead 5/4/11.
(A 2.) (3/31/09*.... C-B 2 ♀.... darker gray, no white on rump....	dead 5/6/09.
♀ B 1. 4/21..... C-B 3..... typical gray.....	dead 12/7/09.
♀ B 2. 4/26..... C-B 4..... "darker gray"; bars not black, dusty blackish; dead 8/15/09.	
C 1. 6/22*.... C-B 5..... typical 2-barred.....	dead 5/12/11.
♀ C 2. 6/23*.... C-B 6..... "dark gray with weak bars"; alive 1912.	
D 1. 7/23..... C-B 7..... typical 2-barred.....	alive 2/7/11.
D 2. 7/25..... C-B 8..... "died young (5 days) but undoubtedly to be 2-barred."	
E 1. 4/10/10..... C-B 9..... typical 2-barred.....	alive 11/1/14.
E 2. 4/12/10..... hatched, neglected.	
♀ F. 6/?*.... C-B 10..... typical 2-barred.....	dead 3/16/13.
G 1. 8/26*.... C-CB 11..... "died before flying." H 1. 11/19; probably not hatched.	
G 2. 8/27*.... C-CB 12..... "died before flying." H 2. 11/21; probably not hatched.	

* Indicates date of hatching.

TABLE 87D.

 δ^3 C. livia (?) (CC 4); 3/29/09; alive 2/7/11; 2-barred from chequered parents. φ C. livia (C-B 7); 7/23/09; alive 2/7/11; typical 2-barred.

δ^3 A. 7/15/10*.... CC-4-A..... juvenal plumage=typical 2-barred; dead 9/25/10.	
--	--

 δ^3 C. livia (?) (CC 3); 3/27/09; 12/3/12; typical 2-barred from chequered parents. φ C. livia (C-B 6); 6/23/09; alive 1912; dark gray with weak bars.

δ^3 A. (date ?)..... 2 C 1.....	dead 1/13/13.
'♀ B 1. (date ?)..... 2 C 2..... 2-barred.....	alive 9/10/12. C 1. 10/15/10, ... 2 C 4.
'♀ B 2. (date ?)..... 2 C 3.....	dead 11/2/12. C 2. 10/17/10, ... 2 C 5.

 δ^3 C. livia (C-B 1); 3/31/09; dead 5/4/11. φ C. livia (4); from Cromarty Caves, Scotland, 1908.

A 1. 8/1/10*.... CB 4 A..... 2-barred.....	dead 4/16/11.
A 2. 8/2/10*.... CB 4 A..... 2-barred; alive 2/7/11 (probably lost tag); escaped 11/26/13.	

 δ^3 C. affinis \times livia (CC-B 2); 3/12/09; 5/12/11; brother; typical 2-barred. φ C. affinis \times livia (CC-B 6); 5/12/09; 1/28/11; sister; typical 2-barred.

A. 9/?/10..... 2 C-B 2..... typical 2-barred.	
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(E, LE)

* Indicates date of hatching.

TABLE 87D (*continued*).

σ^2 C. *livia* (R 11); 3/21/05; 7/25/06; son.
 φ C. *livia* (earlier with *C. livia*, and *C. turbata*); mother.

A. 1/22/06.....	R 17.	B 1. 3/18 *..... R 18.
C 1. 5/3 *.....	R 19..... with few white primaries and 3d bar.	
C 2. 5/3 *.....	R 20..... pure in color and bars; lived less than 2 years.	
D 1. 5/19.....	R 21; no other record; lived less than 2 years.	
D. 2 5/21.....	R 22; no other record; lived less than 2 years.	(XS 2)
<hr/>		
	σ^3 C. <i>affinis</i> \times <i>livia</i> (CC-B 4); 4/7/09; dead before 2/7/11; chequered.	
	φ C. <i>affinis</i> \times <i>livia</i> (?) ¹ (CC-B 10); 7/31/09 to 11/28/11; weakly chequered.	
♀ and ?[A 1. 5/23/10 *.....	2 CC-B 1.....	dead 7/3/13.
[A 2. 5/23/10 *.....	2 CC-B 2 ♀ ; bars and chequers as in dam at same age; ¹ dead 10/5/13.	
B 1. 7/5 *.....	2 CC-B 3..... weakly chequered; disappeared 8/24/10.	
B 2. 7/5 *.....	2 CC-B 4..... typical 2-barred.	
C 1. 7/11.....	2 CC-B 5..... evenly chequered; disappeared before 2/7/11.	
C 2. 7/12.....	2 CC-B 6..... evenly chequered; disappeared before 2/7/11.	(E, LE)

* Indicates date of hatching.

¹ The parentage of this bird is not above suspicion. She was probably a hybrid, *affinis* \times *livia*. "This female (CC-B 10) in juvenal plumage had two very pale bars, as if partially washed out; also a third bar about equally dark. In the adult stage she is weakly chequered on the scapulars, and scantily so on the wings."

CHAPTER X.

ZENAIDURA AND ITS CROSSES WITH ZENAIDA AND HYBRIDS.

The results of crossing mourning-doves (*Zenaidura carolinensis*) with a species of the related genus *Zenaida* are here presented in a series of tabulated breeding records. The data for fertility, sex, and longevity, though not complete, are as nearly so as it has been possible to make them. The records for the breeding of pure mourning-doves and pure zenaidas are also given. Of chief interest, however, is the appearance of a "mutant" from *Zenaida vinaceo-rufa* and the behavior in inheritance of the new character in crosses with *Zenaidura* and its hybrids. The full consideration of this "mutation," together with a large group of illustrations, is given in Chapter IX of Volume I, where the nature and phylogenetic relations of the "new" character are treated (by the author) in connection with the broader subject of the direction of evolution of the color-pattern of pigeons in general. Much of the present textual statement and a tabulated summary have been supplied by the editor; the author's statements are here given the form of quotations.

The records for 6 pairs of mourning-doves¹ (tables 89 and 90) show that these birds breed in captivity with nearly full fertility. In reciprocal crosses with the closely related genus *Zenaida* they are about equally fertile (tables 91 and 93). This is a result parallel to that already found (Chapter VII) in crosses of two other genera which are not distantly related to each other, *Turtur* and *Streptopelia*. Even *inter se* matings of these hybrids (tables 94, 95, 97, 98) are almost fully fertile; when back-crossed to the parent species they are, with *Zenaida* at least (table 96), quite fertile. This maintenance of high fertility by the mourning-doves in their crosses with *Zenaida* is, however, in marked contrast with the very low fertility of mourning-doves when crossed with the much more distantly related forms (*Streptopelia*) to be described in Chapter XI.

The inbreeding of 3 pairs of hybrids supplies a group of offspring of shorter life-term than is elsewhere found in these records. The data are fully given in table 97.

A short consideration only will be given here to the "mutation" which arose in the breeding of *Zenaida vinaceo-rufa* Ridgway. A statement concerning its character and origin, and another touching upon its behavior and permanence in a long line of the breeding tests, must suffice.² The various tabulations present most of the data specially germane to the present volume.

In this "mutation" we have to do with (1) a "mutational" color-character—a white triangular mark at the tip of all of the feathers of several parts of the body; (2) the "mutational" character exists only in the juvenal plumage, the adult plumage of mutant and normal being alike; (3) the new character is clearly a strong modification of a region of the feather which is already differentiated slightly in the direction of the much-strengthened "new" character; (4) the mutational character exists as a specific character in *Columba guinea*, in some other pigeons,

¹ See plate 19.

² As noted above, most features of this mutation are fully treated in Chapter IX, in Volume I. Only the breeding data may appropriately be considered here.—EDITOR.



Adult male mourning-dove, *Zenaidura carolinensis*. $\times 0.8$. Hayashi del., Jan. 1909.

and in still other groups of birds; (5) the zenaidas possessed the character in an earlier stage of their phylogenetic history;³ (6) the "mutational" character persisted, and still persists, through several generations in crosses with *Zenaidura carolinensis* and its hybrids; (7) the character behaves in inheritance rather more as a "dominant" than as a "recessive," but there is some reason to believe that its behavior, as exhibited in the generic cross in which it has been perpetuated can not be accurately described in terms of "dominance."

The pedigree of the "mutant" (No. 21, see pl. 84, Vol. I) and of her mother (12, pl. 83, Vol. I) are given in table 92. The following statement concerning the "mutant" is taken from the record:

This bird was hatched September 28, 1906. The front and sides of the head, neck and breast, and abdomen, the wings and scapulars, and under tail-coverts, and even the tail-feathers (below), are all marked with this mid-terminal, triangular "white spot," which is the characteristic mark in the wing of the guinea-pigeon (pl. 81, Vol. I).

This bird is just a little larger than is No. 20 (which is of normal color, hatched August 18, 1906, from the same parents), but only a little younger. Both birds are now (November 9, 1906) in juvenal plumage and can be compared and photographed side by side. No one would take them for the same species, and yet they are from the same pure-bred parents.⁴ I expect that these marks will disappear in the adult plumage.⁵ If they do, then we have what might be called a juvenal-stage mutation. In other words, a character with all the appearance of a mutation, but transient.

It is important to know if this character is *entirely* new, or if it is a great enlargement of a minute feature of the normal juvenal feathers. The photograph of No. 20 shows just a beginning of this character on the neck—just a mere line. This terminal dividing-mark is not white in the normal form, but pale buff or pale brown. I have seen the same mark nearly and of similar color in some young Japanese and European turtle-doves, in young *Leptoptila*, and in the young of Florida ground-doves.

This character (white triangular mark) is a permanent character in the African guinea-pigeon. In this species we should have no doubt about calling it a character. The mutationist would hold that it is an *immutable unit*. Yet we see that it certainly is only an enlargement of the very minute dividing-line. Even in this specimen it is reduced to mere lines on the crown of the head and on the throat. What appears then to be a mutation turns out to be *not a really new thing*, but an extension and intensification of the normal mark.

Is there any explanation for this? I can account for it only by referring it to the hard time the bird passed during the first 2 or 3 days of its life. . . . It may be that the *lack of food* for the first two days was the cause of this enlarged mark—a sort of albinism.⁶ (CC 0)

It will be seen from table 93 that the "mutant" was bred when 1 and 2 years of age to a male *Zenaidura carolinensis*. The "mutant" offspring in this cross seem to arise chiefly from the stronger germs.

³ See Chap. IX, Vol. I.

⁴ The original records for the breeding of *Z. vinaceo-rufa* are not available to the editor; the descriptions in connection with the *Zenaida* "mutant" and of the several *Zenaida* hybrids form most of the materials at hand.—EDITOR.

⁵ This prediction proved entirely true.—EDITOR.

⁶ In a note dated two years later (in 1908) Whitman wrote: "This 'mutant' (21) hatched September 28, 1906, from the *second* egg of the clutch," underlining the words "September" and "second." In view of the other data then at hand on the relation which both season and the order of the eggs of clutch bear to the "strength of germs" it seems certain that these points were at the latter date, to his mind, the most important considerations bearing upon the appearance of this "mutation." At this later date he had also found, of course, that the mutational character was *inherited*, and was, therefore, not a phenomenon of merely transitory and somatic value.—EDITOR.

This mutant (21) hatched September 28, 1906, from the second egg of the clutch. . . . In the midst of a mating with a mourning-dove she was noted on July 9, 1908, to have weak legs (probably she was weakening before this was observed). In her breeding she began strongly to transmit her juvenal (mutant) pattern, but as she weakened the male gained control and produced the normal type (italics are the author's). (K, C 000)

The result of breeding from the first of the daughter "mutants" is given in table 94. It is clear that the mutational mark was strongly inherited in this the second generation. Its inheritance in the third generation is shown under pair 2 of the same table.⁷ A glance at table 95 will show that one of the normal daughters of the original mutant gave no evidence of power to produce mutants when mated with a complex *Zenaida* × *Zenaidura* hybrid.

The several succeeding tables already referred to in another connection show that none of the many combinations of *Zenaida*, *Zenaidura*, or of their hybrids⁸ give any suggestion of forms similar to mutant No. 21 and her mutant progeny.

In this *Zenaida* mutation (No. 21), then, we have to do with a striking departure from the normal, with a character which exists in the juvenal plumage only, with a character which is firmly fixed in heredity; and the bird which originally displayed this character was known to have originated from a germ which was developed under those conditions which have elsewhere shown themselves to be associated with "weakness" of germs.

The data on the inbreeding of three pairs of *Zenaida-Zenaidura* hybrids (matings of brother and sister) are given in table 97. The result, in all the matings, is a low fertility and a shortened life-term of the offspring.

An analysis of the sex-data obtained from all of the matings recorded in this chapter is attempted in table 99. Three points are considered: (1) the sex-ratio (upper row) from (a) pure-bred matings, from (b) matings of hybrid males with pure-bred females, (c) various hybrid combinations (two groups); (2) the ratio of males to females (middle row) from eggs laid before July 1; and (3) the relation of the order of eggs in the clutch (lower row) to sex, in mating in which (a) pure females and (b) hybrid females were the producers of the eggs.

By reference to the table it will be seen that in matings of *carolinensis* × *carolinensis* the ratio of males to females is 10 ♂ : 12 ♀. When crosses were made, using pure (not hybrid) females (*carolinensis* and *vinaceo-rufa*), this ratio was 20 ♂ : 14 ♀. From crosses in which the female is hybrid the ratio was 15 ♂ : 14 ♀. The corresponding figures prior to July 1 are, 4 : 6, 11 : 7, and 8 : 4. The relation of sex to egg of clutch is of interest, and the effect of hybridization upon this order is well shown. Pure-bred females produced the two sexes in each of 15 clutches; 12 of these threw males from the first and females from the second egg, the reverse in 3 cases. But hybrid females yielded 6 such pairs in which only 3 threw the sexes in the more usual order, and in an equal number of pairs this order was reversed.

⁷ This stock has been maintained by the editor since 1910, and has thrown normals and mutants much as in the record given above. The breeding of the "mutant" series was actively done during 1911, 1912, and 1915. A further statement concerning the later results will at some time be published.—EDITOR.

⁸ *Zenaida* and *Zenaidura* present several contrasting characters to which slight reference is made in the tables. It will be noted that for most of these characters Whitman had found that the characters "fractionated," and that even in the F₂ and complex hybrids there was often little evidence of segregation. One of these hybrids is shown in pl. 20.—EDITOR.

This group of birds, like other groups already considered, indicates, therefore, that in females of pure species—not hybrid—the order of the eggs in the clutch is correlated with sex. There are, too, plain indications here as elsewhere that not only does the act of (wide) hybridization affect the sex-producing capacity of a given pair or group of eggs from pure parents, but in the resulting hybrids the normal relations between sex and the order of the eggs is also affected or modified.

TABLE S9.

Pair A.

σ^3 Zen. carolinensis (2); from dealer (very young) in 1896.
φ Zen. carolinensis (2); from dealer (very young) in 1896.
σ^3 A 1. 4/26/97.....alive 4/29/99.....24+ mo.
φ A 2. 4/28/97.....escaped 4/29/99.....24+ mo.
σ^3 B 1. 5/27.....hatched.
σ^3 B 2. 5/29.....hatched.
C. 6/26.....thin shell, broken.

F 1. 3/8/98.....thin shell, broken.
F 2. 3/10/98.....thin shell, broken.

G. 4/2.....thin shell, broken.

H 1. 4/9; broken.

H 2. 4/11; broken.

I 1. 4/24.....died on trip at 2½ weeks.

I 2. 4/26.....not hatched.

LL 1. 3/7/99.....soft shell.

LL 2. 3/7/99.....soft shell.

M 1. 4/24; no development.

M 2. 4/26; no development.

φ N 1. 5/28.....dead 12/16/99.....6½ mo.
 φ N 2. 5/30.....dead 12/29/99.....7 mo.

Q 1. 4/13/00.....soft shell.

Q 2. 4/15/00.....soft shell.

R 1. 5/2.....killed by parents at 1 day.

R 2. 5/4died at 1 week.

D 1. 7/14.....dead 8/4/97 at 6 days.
 σ^3 D 2. 7/16.....killed 10/16/97.....3 mo.

φ E 1. 8/18.....dead 7/20/98.....11 mo.
 φ E 2. 8/20.....dead 10/20/97.....2 mo.

σ^3 J 1. 6/2.....dead 2/18/00.....20½ mo.
J 2. 6/4; no record.

σ^3 K 1. 7/3.....dead 1/1/00.....18 mo.
 φ K 2. 7/5.....hatched.

φ L 1. 7/30.....hatched.
 σ^3 L 2. 8/1.....alive 5/7/01.....33+ mo.

φ O 1. 6/27.....dead 12/24/99.....6 mo.
O 2. 6/29.....probably not hatched.

P 1. 7/29.....dead 10/6/99.....2 mo.
P 2. 7/31.....hatched.

S 1. 6/10.....hatched.
S 2. 6/12.....hatched.

T 1. 7/12.....hatched.
 φ T 2. 7/14.....dead 1/20/01.....6 mo.

(CC 13, EM 7)

TABLE 90.

Pair B.

Zen. carolinensis (1); hatched 1896; dead 8/?/99; 36 mo.

Zen. carolinensis; from dealer May 1896; dead 4/27/98; 24+ mo.

A. 3/24/97; broken.

C 1. 5/10; developed nearly to hatching (disturbed).

C 2. 5/12; hatched, dead (exposure) at 3 days.

D 1. 6/4; no record.

D 2. 6/6; no record.

E. 6/14; broken.

F. 6/23; thin shell, broken.

B 1. 4/18; apparently not tested.

B 2. 4/20; apparently not tested.

G 1. 7/1/97; lost on trip.
G 2. 7/3/97; lost on trip.

σ^3 H 1. 7/20; hatched, exposed, died at 11 days.

H 2. 7/22; hatched, dead 11/9/97; 3½ mo.

(EM 7, C 7, 22)

Pair C.

σ^3 Zen. carolinensis (2-A 1); 5/11/97; brother; (death?).

φ Zen. carolinensis (2-A 2); 5/13/97; sister; escaped 4/29/99.

"One or two clutches laid with thin shells," then:

A 1. 6/8/98.....hatched.....dead about 7/20/98.....6 weeks.
A 2. 6/10/98.....hatched.....dead about 7/20/98.....6 weeks.

B 1. 7/10.....hatched.....dead 8/20/98.....41 da.
B 2. 7/12.....hatched.....dead 8/20/98.....39 da.

σ^3 C 1. 8/4.....hatched.....dead 10/28/98.....3 mo.
 φ C 2. 8/6.....hatched.....(killed) 1/4/99.....5+ mo.

D 1. 4/26/99; probably did not hatch.

D 2. 4/28/99; probably did not hatch.

(CC 9)

TABLE 90 (*continued*).*Pair D.*

σ^3 Zen. carolinensis (1); 1904 or earlier.	
φ Zen. carolinensis (1); 1904 or earlier.	
A 1. 5/4/05.....5.....	no later record.
A 2. 5/6/05.....6.....	dead 1/22/06.
C 1. 7/5*.....9.....	dead 9/15/05.
C 2. 7/6*.....10.....	dead 12/16/05.
D 1. 7/31.....13.....	probably died early.
D 2. 8/2.....14.....	dead 9/23/05.

Pair E.

σ^3 Zen. carolinensis (C 3).	
φ Zen. carolinensis (2); 1904 or earlier.	
♀ A 1. 5/8/06*.....10.....	killed (accident) at 10 weeks.
A 2. 5/8/06*.....10.....	no later record.
σ^3 B 1. 5/27.....11.....	alive 8/2/08.
B 2. 5/29.....11.....	dead 8/18/06.

Pair F.

σ^3 Zen. carolinensis (PP 3); taken wild near Chicago, 6/6/07.	
φ Zen. carolinensis (S. M. 1); from Santa Martha, U. S. Colombia, 5/29/07.	
A 1. 6/16/08*; thrown from nest.	σ^3 B 1. 7/18*; 21; dead 12/4/08.
A 2. 6/17/08*; 20; no later record.	B 2. ; did not hatch.

* Indicates date of hatching

C 1. 8/9*; 22.
C 2. 8/10; 23.

(Sh. 28).

TABLE 91.

 σ^3 Zenaida vinaceo-rufa.¹ φ Zenaidura carolinensis.

σ^3 A 1. 4/10/05.....ZZ 1.....	dead 3/22/09.....	47 mo. (see pl. 20).
♀ A 2. 4/12/05.....ZZ 2.....	dead 6/18/06.....	14 mo.
σ^3 B 1. 5/10.....ZZ 3.....	dead 7/16/06.....	14 mo.
σ^3 B 2. 5/12.....ZZ 4.....	dead 9/13/09.....	52 mo.
σ^3 C 1. 5/18.....ZZ 5.....	alive 10/1/14.....	113+ mo.
? ♀ C 2. 5/20.....ZZ 6; "color indicates it is a ♀," disappeared or dead before 2/5/11.		
D 1. 6/19; developed embryo, deserted.	E 1. 7/7; no development.	
D 2. 6/21; developed embryo, deserted.	σ^3 E 2. 7/9.....ZZ 7.....alive 5/21/07.....	22+ mo.
F 1. 8/4; one broken, other developed, but was deserted.		
F 2. 8/6.....ZZ 8.....	alive 6/1/09.....	46+ mo.
? G 1. 8/13.....ZZ 8.....	dead (fright) 7/30/07.....	24+ mo.
? G 2. 8/15.....ZZ 9.....		
? H 1. 9/30.....hatched.....	dead 2/26/06.....	5 mo.
? H 2. 10/2.....hatched.....	dead 1/4/06.....	3 mo.
I. 1/26/06; did not hatch.	J.; a dwarf egg.	K. 4/4/06; did not hatch.
♀ L 1. 4/16.....ZZ 10.....	dead 2/23/08.....	22 mo.
L 2. 4/18.....ZZ 11.....	.no later record.	
M 1. 5/16; failed to develop (possibly deficient incubation).		
M 2. 5/18; failed to develop (possibly deficient incubation).		
N 1. 6/9.....hatched; died early.	σ^3 O 1. 7/25 (hatch.).....ZZ 12.....	matured, mated.
N 2. 6/11.....hatched; died early.	φ O 2. 7/26 (hatch.).....ZZ 13.....	alive 10/10/06.
P 1. 8/7.....hatched.....	died at 1 day (care ?).	
? P 2. 8/9.....ZZ 14.....	alive 8/3/08.....	24+ mo.

¹ It is not absolutely certain that this *Zenaida* was *vinaceo-rufa*.—EDITOR.

(CC 3)

TABLE 92.—*Reconstructed¹ breeding record of Zenaida vinaceo-rufa, 1905–6.**Pair 1.*

σ^{δ} Zenaida vinaceo-rufa (2); (imported, probably from Venezuela, 1904).
♀ Zenaida vinaceo-rufa (2); (imported, probably from Venezuela, 1904).
♀ and ? { 1. 5. 26. 05* 11 normal; dead 3/7/07.
? 2. 5. 27. 05* 12 ♀ normal, shade darker than 13 (see pl. S3, Vol. I).
? 1. 6. 21* 13 normal, shade lighter than 12.
? 2. 6. 25* 14 normal? or weak mutant?, shade lighter than 13.

Pair 2.

σ^{δ} Zenaida vinaceo-rufa (0); imported, from Venezuela 1905.
♀ Zenaida vinaceo-rufa (12); 5/27/12 (see above, and pl. S3, Vol. I).
? } 8/18/06* 20 normal, alive 6/10/07 (see pl. S4, Vol. I).

? 1. 8. 12(?) ; not hatched.
 ♀ ? 2. 9/28/06* 21 ♀ MUTANT; dead 9/21/08 (see pl. S4, Vol. I).

¹ Complete records were of course made by the author, and I find specific references to them; but unfortunately they are not available to the editor. The tabulation represents that part of the record which is *repeated*; either in summary comment, on breeding records (where these offspring were used as parents), or in legends for illustrations, etc. The interrogation points in the first column indicate that the *number of eggs* which had been laid during the season *prior to* the egg described, is unknown.—EDITOR.

* Indicates date of hatching.

TABLE 93.—*The breeding of "mutant" Z. vinaceo-rufa No. 21.*

σ^{δ} Zenaidura carolinensis (11); 5/27/06.
♀ Zenaida vinaceo-rufa MUTANT (21); hatched 9/28/06; 9/21/08; 24 mo. (see pl. S4, Vol. I).
♀ A 1. 7/15/07 Z-ZN 1 "mutant" on breast, lower neck, sides of head 10/11/11 51 mo.
A 2. 7/17/07 Z-ZN 2 normal 12/5/07 4½ mo.
B 1. 3/21/08; failed to hatch (exposure).
B 2. 3/23/08; failed to hatch (exposure).
♀ C 1. 3/28 Z-ZN 3 "mutant," strong except at bend of wings and back; 5/17/08 1 mo.
C 2. 3/30 Z-ZN 4 relieved, died before feathering ½ mo.
♂ D 1. 4/10 Z-ZN 5 mutant, strong on head, breast and wings 1/25/10 21½ mo.
♀ D 2. 4/12 Z-ZN 6 normal or nearly 3/19/10 23 mo.
♂ E 1. 4/24 Z-ZN 7 normal, like D 2 10/1/10 29 mo.
E 2. 4/26 Z-ZN 8 normal, like D 2 6/9/08 1½ mo.
F 1. 5/14; developed near to hatching, but parents deserted.
F 2. 5/16; developed near to hatching, but parents deserted.
G 1. 6/19; "development not completed."
G 2. 6/21; "development not completed."

"I now notice (7/9/08) that the dam (21) is not quite well—legs weak; this continued¹ till death (9/21/08)."

♀ H 1. 7/11 Z-ZN 9 normal 1/20/09 6 mo.
II 2. 7/13; fully developed embryo, thrown from nest and broken.
I 1. 7/31; "failed to develop."
I 2. 8/2; "failed to develop."
(K, CCOO)

¹ The weakening probably began some time before noticed. This female (21) began strongly transmitting her juvenile pattern, but as she weakened the male gained control, and produced the normal type."

TABLE 94.—*The breeding of the offspring of the Zenaida mutation.**Pair 1.*

σ^{δ} Zenaida-Zenaidura \times Zenaida hyb. (ZZ-ZN 1); 5/12/07; disappeared or dead before 2/7/11; normal color.
♀ Zenaidura \times Zenaida (= "Mutant" Z-ZN 1; 7/15/07; dead 10/11/11.
A 1. 7/4/09(=2 Z-3 ZN 1) color normal, dead 7/18/09 14 da.
A 2. 7/4/09(=2 Z-3 ZN 2) mutant strongly marked dead 7/15/09 11 da.
B 1. Did not hatch.
B 2. 8/14* 2 Z-3 ZN 3 normal color alive 2/7/11 18+ mo.
♀ and ? { C 1. 9/9*(one=2 Z-3 ZN 4) mutant dead 11/11/11 26 mo.
{ C 2. 9/9*(one=2 Z-3 ZN 5) normal color dead 6/2/10 9 mo.

* Indicates date of hatching.

TABLE 94 (*continued.*)

D. 2/10/10; soft shell.	E 1. 2/20; thin shell. E 2. 2/22; laid on floor, broken.
F 1. 4/3 2 Z-3 ZN 6 mutant	disappeared 2/7/11-11/4/13 12+ mo.
F 2. 4/5; did not hatch.	
♂G 1. 5/24* 2 Z-3 ZN 7 mutant	dead 1/15/14 44 mo.
♂G 2. 5/26* 2 Z-3 ZN 8 mutant	alive 10/1/14 52+ mo.
♀H 1. 6/25* 2 Z-3 ZN 9 mutant	dead 6/7/13 35 mo.
H 2. 6/25* 2 Z-3 ZN 10 mutant	dead 7/19/12 24½ mo.

Pair 2.

♂ Zenaida × Zenaida-Zenaidura × Zenaida hyb. (3ZN Z 2); 7/7/09; 6, 16, 14; 59 mo.
♀ Zenaida-Zenaidura × Zenaida × Zenaidura-Zenaida "mutant" hyb. (2Z-3ZN 4); 7/15/07; 52 mo.
♀ A 1. 5/28/10 3 Z-6 ZN 1 "mutant" head, neck, breast and beneath; alive 10/1/14.
A 2. 5/30/10 3 Z-6 ZN 2 normal color.
"Some eggs laid that failed between June and September."
B 1. 9/11 3 Z-6 ZN 3 "strong mutant."
B 2. 9/13 3 Z-6 ZN 4 "good, but little weaker mutant."

(Misc. 2, XX 6)

* Indicates date of hatching.

† One bird with this mark is recorded as a female, dead 1/17/12, but a bird (also female) still lives (10/1/14) bearing this tag.—EDITOR.

TABLE 95.—*Further breeding of the offspring of the Zenaida "mutation."*

♂ Zenaida-Zenaidura × Zenaida hyb. (ZZ-ZN 14); 5/29/08; 4/25/10; 23 mo.
♀ Zenaidura × Zenaida (normal) hyb. (Z-ZN 6); 4/12/08; 3/19/10; 23 mo.
"Three young during 1909, which I mark as follows (no record of time of laying or hatching):"
♀ ZA; fertile (w. ZZ 5). ♂ ZB; fertile (w. 3ZN-Z 1). ? ♀ ZC. —
♂ Zenaida × Zenaidura hyb. (ZZ 5); (paternal grand-sire of present mate).
♀ ZA (see immediately above) hyb. 1909; escaped about 7/1/11; 24+ mo.; granddaughter.
♂ A 1. 5/10/10 one 3 Z-4 ZN 1 normal (i.e., not "mutant") 14 rectrices; dead 11/12/11 (♂). ♂ A 2. 5/12/10 one 3 Z-4 ZN 2 normal (i.e., not "mutant") 14 rectrices.
♂ B 1. 6/14 3 Z-4 ZN 3 normal color 14 rectrices dead 8/31/10 2½ mo.
♂ B 2. 6/16 3 Z-4 ZN 4 normal color 14 rectrices escaped 7/6/13 37+ mo.
C 1. 7/2; was not hatched. D 1. 7/2; broken.
C 2. 7/2; was not hatched. D 2. 7/2; broken.
♀ D 1. 7/21 3 Z-4 ZN 5 normal 14 rectrices dead 11/19/10 (cold?) 4 mo.
D 2. 7/23 3 Z-4 ZN 6 normal 14 rectrices.
(Two clutches marked D)
♂ E 1. 9/18 3 Z-4 ZN 7 normal 14 rectrices; disappeared 11/4/13-10/1/14 39+ mo.
♀ E 2. 9/20 3 Z-4 ZN 8 normal 14 rectrices; dead 10/16/10 1 mo.

(H)

♂ ZB (for composition see second section above, this table); hyb. 1909.
♀ Zenaida × Zenaida-Zenaidura × Zenaida hyb. (3ZN-Z 1); 7/5/09; 11/17/13; 54½ mo.
Both parents have 14 tail feathers.
♀ A 1. 6/14/10 3 Z-6 ZNA color normal, 15 rectrices; 8 right, 7 left; alive 10/1/14 52+ mo.
♂ A 2. 6/16/10 3 Z-6 ZNA color normal, 14 rectrices; dead 7/24/12 25 mo.

♂ A 3 and ? B 1. 8/22 3 Z-6 ZNB normal¹ 14 rectrices; dead 7/17/12 23 mo.

♂ B 2. 8/24 3 Z-6 ZNB normal 14 rectrices; dead 9/4/12 (♂) 24½ mo.

¹ The original data for some later (known and living) offspring of this composition are not available to the editor.

TABLE 96.

♂ Zenaida × Zenaidura hyb. (ZZ 1); 4/10/05; 3/22/08; 35 mo.
♀ Zenaida (2).
A 1. 4/30/07 ZZ-ZN 1 dead very early, but data not recorded.
A 2. 5/2/07 ZZ-ZN 2 hatched "seemed well, but dead 6/25/07," at 9 days.
♂ B 1. 5/12 ZZ-ZN 1 mated (fertile) disappeared or dead before 2/5/11.
B 2. 5/14; did not hatch.
C 1. 6/3 ZZ-ZN 2 dead before 2/5/11
C 2. 6/5 ZZ-ZN 3 dead 11/12/07 5 mo.
♂ D 1. 7/25 ZZ-ZN 8 mated (fertile) tuberculosis; killed 9/12/08 14+ mo.
♂ D 2. 7/27 ZZ-ZN 9 dead 11/9/07 3½ mo.
♂ E 1. 9/1 ZZ-ZN 10 dead 11/3/09 26 mo.
♀ E 2. 9/3 ZZ-ZN 11 tail short, feathers pointed; dead 11/16/07 21 mo.

(CC 2)

TABLE 96 (*continued*).

σ^1 A 1. 6/1/07.	ZZ-ZN 4	dead 10/21/11	52 mo.
σ^1 A 2. 6/3/07.	ZZ-ZN 5	disappeared between 7/5/11 and 11/4/13	50+ mo.
σ^1 B 1. 8/4.	ZZ-ZN 6	dead 9/27/10	38 mo.
σ^1 B 2. 8/6.	ZZ-ZN 7	"typical $\frac{1}{4}$ hybrid"; dead 12/13/07	4 mo.
<hr/>			
C 1. 4/2/08; not hatched (care ?).			
C 2. 4/4/08; not hatched (care ?).			
σ^1 D 1. 5/13.	ZZ-ZN 12	disappeared ¹ between 7/5/11 and 11/5/13	40+ mo.
σ^1 D 2. 5/15.	ZZ-ZN 13	alive 10/1/14	77+ mo.
σ^1 E 1. 5/29.	ZZ-ZN 14	dead 4/25/10	23 mo.
σ^1 E 2. 5/31.	ZZ-ZN 15	(fertile, see below); dead 1/25/10	20 mo.
			(CC 1, CC 2)

 σ^1 Zenaida vinacea-rufa (6); imported 1907. σ^1 Zenaida-Zenaidura \times Zenaida hyb. (ZZ-ZN 15); 5/31/08; 1/25/10; 20 mo.

A 1. 5/1/09; failed to hatch.			
A 2. 5/3/09.	ZN-ZZ-ZN 1	died at end of two weeks; not well fed.	
σ^1 B 1. 7/5.	3 ZN-Z 1	dead 11/17/13	52½ mo.
σ^1 B 2. 7/7.	3 ZN-Z 2	dead 6/16/14	59 mo.
			(CC 5)

¹ This bird functioned as a male and laid no eggs, but there was no autopsy.

TABLE 97.

Pair 1.

 σ^1 Zenaida \times Zenaidura hyb. (ZZ 3); 5/10/05; 7/16/06; 14 mo.; brother. σ^1 Zenaida \times Zenaidura hyb. (ZZ 2); 4/12/05; 6/18/06; 14 mo.; sister.

A 1. 5/9/06.	hatched, dead at 10 to 12 days.	
A 2. 5/11/06.	hatched, dead at 10 to 12 days.	(CC 3, Misc. 1)

Pair 2.

 σ^1 Zenaida \times Zenaidura hyb. (ZZ 7); 7/9/05; brother. σ^1 Zenaida \times Zenaidura hyb. (ZZ 8); 8/13/05; sister.

A 1. 5/2/06; did not hatch.	B 1. 6/11; no development.	
A 2. 5/2/06; did not hatch.	B 2. 6/13; hatched; dead at 2 days (accident ?).	
σ^1 C 1. 9/14.	ZZ-C	
C 2. 9/16.	(fertile), mated; probably dead 5/10/09	32 mo.
D 1. 4/3/07; did not develop (care ?).	E 1. 4/26; deserted.	
D 2. 4/5/07; did not develop (care ?).	E 2. 4/28; deserted.	
F 1. 5/19/07.	ZZ-F	
F 2. 5/21/07.	probably matured. dead on ground at 7 days old.	
	(Misc. 1, CC 3)	

Pair 3.

 σ^1 Zenaida \times Zenaidura hyb. (ZZ-9); 8/15/05; dead (fright) 7/30/07; 24+ mo.; brother. σ^1 Zenaida \times Zenaidura (ZZ-10); 4/16/06; dead 2/23/08; 22 mo.; sister.

A 1. 4/2/07.	ZZ-A	no later record.
A 2. 4/4/07.		hatched, died at about 1 week, not well fed.
B 1. 4/29; no development.		
B 2. 5/1.	ZZ-B	"genuine hybrid; intermediate"
C 1. 5/21.	ZZ-C 2	dead 12/12/07
C 2. 5/23.		7½ mo.
σ^1 D 1. 7/6.	ZZ-D	no record; probably not hatched.
σ^1 D 2. 7/8.	ZZ-D	light, "toward Zenaidura"; probably died 10/20/07
		? 31 mo.
		"darker, intermediate like parents"; 1/5/08
		6 mo.
		(CC 1, CC 3)

TABLE 98.

Pair 4.

σ^3 Zenaida \times Zenaidura hyb. (ZZ 14); 8/7/06; alive 8/3/08; 24+ mo.	
φ vinac.-carolin. \times vinac.-carolinensis hyb. (C) 9/14/06; alive 4/1/09; 31+ mo.	
A 1. 4/28/07; deserted.	B 1. 5/12; deserted.
A 2. 4/30/07; deserted.	B 2. 5/14; deserted.
D 1. 5/28.....ZZ-C-D.....	dead 6/14/07 (not fed).
D 2. 5/30.....developed, but shell slightly broken, failed.	
♀ E. 7/1.....ZZ-C-E.....	"typical intermediate".....dead 11/21/07.....5 mo.
σ^3 F 1. 8/13.....ZZ-C-F.....	"like parents".....dead 11/27/07.....31 mo.
♀ F 2. 8/15.....ZZ-C-F.....	dead 2/20/09.....18 mo.
G 1. 3/26/08.....one failed, other broken.	H 1. 4/8; failed to hatch.
G 2. 3/28/08.....	H 2. 4/10; hatched; dead at 7 to 10 days.
I 1. 5/5.....ZZ-C-I-r.....	dead 5/10/09.....12 mo.
I 2. 5/7.....ZZ-C-I-l.....	thrown from nest, killed, early.
J 1. 6/8; hatched.*	K 1. 7/14; hatched.*
J 2. 6/10; hatched.*	K 2. 7/16; hatched.*
σ^3 L 1. 8/1.....ZZ-C-H.....	dead 10/20/08.....2½ mo.
L 2. 8/3....."do not know result."	

Next and last egg from this pair 4/1/09.

(CC 1)

Pair 5.

σ^3 Zenaida-Zenaidura \times Zenaida hyb. (ZZ-ZN 2); 6/3/07; dead or disappeared before 2/5/11.
φ Zenaida-Zenaidura hyb. (ZZ 8); 8/13/05.

σ^3 A 1. 4/25/08.....2 ZZ-ZN 1.....	dead 1 5/23/11.....37 mo.
φ A 2. 4/27/08.....2 ZZ-ZN 2.....	dead 8/1/08.....3 mo.
B 1. 6/20.....2 ZZ-ZN 3.....	died very young.
B 2. 6/22.....2 ZZ-ZN 4.....	died very young.

C 1. 7/21; hatched, died early.

C 2. 7/23; hatched, died early.

(CC 4)

A(?) a young.....2 ZZ-ZN 5.....hatched 6/1/09; dead or disappeared before 2/5/11.

Pair 6.

σ^3 Zenaida-Zenaidura \times Zenaida hyb. ZZ-ZN 8; 7/25/07; killed (tuber.) 9/12/08; 14 mo.
φ Zenaida-Zenaidura \times Zenaida hyb. ZZ-ZN 5; 6/3/07; disappeared after 50 mo.

Paternal (Zenaida) grandparents of these birds were brothers. They are themselves brother and sister.

A 1. 5/29/08.....ZZ-ZNA.....	dead 11/17/09.....17½ mo.
A 2. 5/31/08; no record, probably not hatched.	
σ^3 B 1. 6/14.....ZZ-ZNB.....	14 rectrices.....dead 4/2/09.....8 mo.
B 2. 6/16.....	hatched.....died in nest.
C. 8/6.....ZZ-ZNC.....	dead 12/18/09.....16½ mo.

* Young thrown from nest (fright) and killed.

† Offspring = $\frac{1}{2}$ Zenaida - $\frac{1}{2}$ Zenaidura.

(CC 7)

TABLE 99.—Sex-ratio in breeding and crossing of mourning-doves with Zenaida.

I Car. \times Car.		II Zen. \times Car.		III Car. \times Zen.		IV Hyb. \times Zen.		V Total.		VI Zen. \times Hyb.		VII Hyb. \times Hyb.		VIII Comp. Hyb.		IX Total.		
σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	σ^3	φ	
10	12	9	6	2	4	9	4	20	14	1	1	1	1	2	13	11	15	14

No. of males and females before July 1.

4	6	4	3	2	2	5	2	11	7	0	0	0	0	0	8	4	8	4
---	---	---	---	---	---	---	---	----	---	---	---	---	---	---	---	---	---	---

Pairs of eggs in which first egg produced male, second egg female (A); and reverse (B).

A	B	A	B	A	B	A	B	A	B	A	B	A	B	A	B		
4	1	3	2	1	0	4	0	8	2	0	1	0	1	3	1	3	3

Total for pure females (A-B), 12 to 3. Total for hybrid females, 3 to 3.

CHAPTER XI.

BLOND AND WHITE RING-DOVES CROSSED WITH MOURNING-DOVES, COMMON PIGEONS, AND THE EUROPEAN TURTLE-DOVE.

The three groups of crosses presented here afford an additional opportunity to observe the following facts or situations: (1) the reduced fertility which follows from the mating of forms more and more separated phylogenetically; (2) the appearance of males exclusively in the progeny resulting from the most distantly related crosses; (3) the effects of season and hybridism on fertility and sex, and in isolated instances of the effect of season on the dominance of color.¹

The same forms—blond and white ring-doves—were mated to mourning-doves, which are classed in a different subfamily, with common pigeons, which belong to a different family, and with the European turtle-dove, which belongs to a related genus. The generic and subfamily crosses were more fertile than those of family difference, and from the crosses of genera both male and female young were obtained. The crosses involving birds of different families gave only male offspring, except in two isolated instances in which hybrid males were used with a female (homer?, stray bird) of uncertain (hybrid?) origin. From these pairs 3 birds were obtained which were classed as females, but this classification was probably based solely upon their *behavior* in copulation; no sex data, obtained at the time of death, can be found for either of these three offspring. The subfamily crosses gave also only male offspring. The generic cross described here is apparently perhaps less fertile than the subfamily cross, due chiefly to the high degree of hybridism involved in the birds used as parents, and to more extensive inbreeding in this series of generic crosses.

Complex hybrids were formed in the various groups, and these afforded opportunity for a study of the possibility of the “splitting” of the very distinct characters of the very distinct parental forms. This particular aspect of the results is, however, separately considered in Chapter XVII. In the crosses of the ring-doves with the turtle-dove there is found a limitation of the inheritance of color by sex. In the first group of crosses a number of birds were used as parents whose exact origin may be obtained from the breeding data which is tabulated in connection with the preceding chapter.

BLOND AND WHITE RINGS CROSSED WITH THE MOURNING-DOVE AND ITS HYBRIDS.

In crosses of the mourning-dove, and of several grades of its hybrids, with the closely related genus *Zenaida*, all were found (in the preceding chapter) to be almost or quite completely fertile. 12 matings of these forms with other doves which are commonly classed in a different subfamily are here recorded, and a low or an extremely low fertility is found in every case; 5 of these pairs (tables 100 to 102) involve the primary cross—*Zenaidura carolinensis* × *St. risoria*; 4 pairs (tables 103 and 104) are pure *carolinensis* × *risoria-alba* hybrids (F_2 of reciprocal crosses); 2 pairs (tables 105 and 106) are F_1 male *Zenaida* × *Zenaidura* hybrids mated with female pure *St. risoria* in one case and with pure *St. alba* in the other. A twelfth

¹ It has been found necessary for the editor to write this and other introductory matter for most of the subdivisions of the present chapter.

pair (table 107) is formed of a complex *Zenaida-Zenaidura* hybrid mated to a complex *risoria-alba* hybrid.

It is clear that some of these matings are more fertile than are others; but it is not at all apparent that the primary cross is more fertile or less fertile than the crosses of the hybrids. The differences in the fertility of *individuals* is doubtless a complicating factor here. The dissimilar distribution of the eggs over the seasons, and unequal overwork for some pairs, are other variables which make a comparison difficult. It may usually be observed, however, that there is a much decreased fertility after July.

From none of these matings were female offspring obtained. The matings in which pure females were used yielded 16 males and the hybrid females 6 males. It is of interest to note the number and proportion of young possessing no sex-glands which arose in these fraternities. The pure female parents that gave 16 males produced 1 such young; the hybrid females produced in addition to 6 males, 3 offspring with no gonads, and another with very minute testes or testis-like bodies.

Since the mourning-dove and the mourning \times *Zenaida* hybrid have several very sharply defined color-marks or spots and the blond ring has a uniform coloration, it is of interest to note some features of color inheritance in these hybrids. The mourning-dove is shown in pl. 19; the blond ring has been already seen in pl. 8. The following description applies to one of the hybrids ($\sigma H 1$ of April 24, 1900, of table 101) of these two forms.

With regard to "the spots on the tertials it would seem at first sight as if there were 'no traces' whatever. On lifting the feathers, about 3 of the upper tertials are found to have 'dusky areas' on the inner webs, with no distinct outlines, but corresponding in position with the elongated spots of the mourning-dove."

There are no distinct spots on the lesser coverts, but some of them, when lifted, display on the basal half a dusky gray in the place of the spots found in the mourning-dove. These dusky-gray areas are often quite clearly outlined or bounded distally, like the "imprints" I once discovered in the white-wing pigeon (*Melopelia*).

At first glance it would be thought that there is no ring and no iridescence in the hybrid. On closer view, I see that about 4 rows of feathers on the side of the neck (corresponding to

EXPLANATION OF PLATE 20.

- A. Juvenile male *Zenaida-Zenaidura* \times *Streptopelia risoria* hybrid (ZZ-R 1). Hatched from egg of May 3, 1908 (table 105). Seven-tenths natural size. K. Hayashi del., July 1908.

Sire: *Zenaida* \times *Zenaidura* hybrid (ZZ 1 of this plate). Dam: *St. risoria*.

The juvenile feathers are much as in juvenile mourning-doves, but considerably lighter (pale edges as in the mourning-doves and ring-doves) and the spots are fewer and duller. *Vestiges* of spots are found on the outer web of the inner tertials and on the inner large coverts. The tail feathers are 12 in number (as in the dam); the two mid-feathers are 0.25 inch longer than other rectrices (this is intermediate to the mourning-doves and the ring-doves), but are rounded (this is toward *Zenaidura* and *risoria*) rather than pointed.

- B. Adult male *Zenaida* \times *Zenaidura* hybrid (ZZ 1). Hatched from egg of April 10, 1905 (table 91). Seven-tenths natural size. K. Hayashi del., May 1906.

In the juvenile plumage the feathers of the back, wings, neck, breast, and forehead were pale-edged, as in *Zenaidura*. Two dark streaks are present on the sides of the head, above and below the ear-coverts. Legs pale red. The black spots are not quite so numerous as on young mourning-doves. The ground color is that of young mourning-doves, but with a shade more of the reddish brown of *Zenaida*. On the breast feathers (juvenile) there is a reddish mid-streak (as in *Leptoptila*), which is wider at the tip and gradually narrowed inward to a point. The reddish is seen at the middle of the tips of the primaries, though there it is not regular in form as on the breast; this also seen in the primary coverts. *It looks as if this were the way the black center became divided into two lateral spots.* If so, it is essentially as in the common pigeon and in *C. livia*. The nest-mate (ZZ 2) of this bird was quite similar to it.



A. Juvenile male, *Zenaida-Zenaidura* \times *Streptopelia risoria* hybrid. (ZZ-R1). Hatched from egg of May 3, 1908. $\times 0.7$. Hayashi del., July 1908. Sire, *Zenaida* \times *Zenaidura* hybrid (ZZ1 of this plate). Dam, *St. risoria*.
B. Adult male, *Zenaida* \times *Zenaidura* hybrid (ZZ1). Hatched from egg of Apr. 10, 1905. $\times 0.7$. Hayashi del., May 1906.

the ring in the ring-dove and to the iridescent area in the mourning-dove) are slightly differentiated in color, having a stronger "vinous" tinge than the other feathers, and having the ends cut a little short and rigid in outline, suggesting the feathers of the ring. These feathers are plainly shorter than other feathers, and in some I notice that one web is cut shorter at the tip than is the other web; in these the ring-differentiation takes effect in *only one web, or in one-half or one-third of one web.* The vinous tinge seems to look plainly towards iridescence, and is in fact slightly iridescent in favorable light. The same description (throughout) applies to hybrid male *I2* of the same series. (A 1/9)

The description of a *carolinensis* \times *alba-risoria* hybrid (A 1, April 8, 1897, of table 103) at the time of its death, 29 days after hatching, is given by the author as follows:

The interesting point in regard to color is the "washed-out appearance of the black spots," and the "reduction in number" of these spots. The general plumage color corresponds with the first plumage of the mourning-dove, but it is notably lighter, as if fading into or towards isabelline. The mother's influence is here apparent. The feathers are all edged with isabelline as in the mourning-dove. The primaries are dark, much as in the mourning-dove, but the edging at the free ends is not so deep and rich.

I note the following concerning the spots: In the young mourning-dove (I have one in hand to compare) the scapulars have each two black spots. In the hybrid these spots are found in a few feathers only, and are half faded out. In mourning-dove young most of the coverts in the upper half of the wing are marked in the same way, the spots becoming larger and more conspicuous posteriorly in the larger coverts. In the hybrid all these spots are absent, or washed out so far as not to be recognizable, except on two of the upper larger coverts, namely, the twelfth and thirteenth, counting upward on the wing. These two feathers have the spot on the outer web, none on inner, and they are smaller than in the mourning-dove, being fully half washed out. Just behind these spots two tertials (tenth and eleventh, counting upward from first secondary) are similarly marked.

In the mourning-dove three tertials (tenth, eleventh, and twelfth) are thus marked, and marked on both webs, with quite conspicuous black spots; the spots on the outer web are the stronger (deeper) black; four of the upper larger coverts (eleventh, twelfth, thirteenth, and fourteenth) are marked, but only one of these (the twelfth) has a spot on the inner web.

The tail of the mourning-dove has 14 feathers, the outermost one of these (on each side) being white; and this feather, together with 3 others, have white tips. In these 4 feathers the extent of the white diminishes gradually until in the fourth most of the tip is ashy blue partly whitened out at the very end. The fifth and sixth feathers are ashy blue throughout (except the bar). The seventh is brown, becoming blue at the base, and without a bar. The outer feather is about four-sevenths as long as the two middle feathers.

The hybrid has 12 tail feathers and thus agrees with the mother. The two middle ones are brown, and taper a little at the end, but far less than in *Zenaidura*.² The outer web of the outer feathers is not "white" but "light ashy blue." The bar, which is similar to that of the mourning-dove, is on feathers 1 to 4, absent on 5 and 6. This outer feather is 80 mm. long; the middle feather is 105 mm. The outer is thus about three-fourths as long as the middle feather. On the under side the bar extends farther towards the base, and a trace of it is seen on the middle feathers. The under tail-coverts are "white," and extend to the outer edge of the bar.

The feathers on the breast—those along the middle line from chin to abdomen—show a vinous tinge similar to those of *Zenaidura*. Elsewhere they are pale brown, edged with isabelline. The color grows lighter backward, whitening out towards the vent. The under wing coverts are pale bluish gray. The eye is dark, but lighter than that of the mourning-dove. The size of the hybrid is clearly between that of mourning- and ring-doves. (CC 16)

² "I have only an adult tail to compare; possibly the difference in the young is less."

The *Zenaida* × *Zenaidura* hybrid (ZZ1) which is used as the sire in table 105 is figured in pl. 20. When this hybrid is compared with the mourning-dove (pl. 19) it is plain that the long tail and the large suborbital spot of the latter have been very perceptibly reduced, and the reddish-brown color increased, in the direction of *Zenaida*. When this hybrid was mated with a blond ring it will be seen by reference to pl. 20 that once more a fair intermediate results—an intermediate not only in the general coloration, but in the specific parts of the color-pattern. The black spots of the *Zenaida* and *Zenaidura* ancestors are again reduced in size and in number toward the uniform color of the ring-dove. The number of tail-feathers (rectrices) in this fraternity was that of the dam (12) in 4 cases, and that of the sire (14) in a fifth individual.

TABLE 100.

♂ Zen. carolinensis (5); hatched 1897.

♀ St. risoria (b); from dealer early 1898.

A 1. 5/9/98; no development.

A 2. 5/11/98; no development.

B 1. 6/3; no development.

B 2. 6/5; no development.

C 1. 6/16; no development.

C 2. 6/18; no development.

D 1. 6/28; probably no development.

D 2. 6/30; probably no development.

E 1. 7/13; no development.

E 2. 7/15; no development.

F 1. 8/18; no development.

F 2. 8/20; no development.

♀ St. risoria (C) given early 1899. From dealer March 1898.

A 1. 4/23/99; no development.

A 2. 4/25/99; no development.

B 1. 5/30; hatched, dead 7/12/99;
6 weeks.

B 2. 6/1; hatched, no later record.

♂ C 1. 6/30; hatched.

♂ C 2. 7/2; hatched.

♂ D 1. 8/1; hatched.

♂ D 2. 8/3; dead at 33 mo.

E 1. 9/8; no development.

E 2. 9/10; no development.

F 1. 10/6; no development.

F 2. 10/8; no development.

G 2. 10/31; no development.

G 2. 11/2; no development.

H 1. 11/24; no development.

H 2. 11/26; no development.

I 1. 12/21; no development.

I 2. 12. 23; no development.

J 1. 5/29/00; no development.

J 2. 5/31/00; no development.

♂ K 1. 6/16; hatched; dead 11/1/02 at
29 mo.♂ K 2. 6/18; hatched; dead 10/20/10 at
4 mo., "no distinct sex-
glands."L 1. 7/3; not hatched (♂ does not
incubate well).L 2. 7/5; not hatched (♂ does not
incubate well).♂ M 1. 7/12; hatched; dead 9/25/00 at
2½ mo.

M 2. 7/14; hatched.

N 1. 8/18; no development.

N 2. 8/20; hatched.

O 1. 10/6; no development.

O 2. 10/8; no development.

P 1. 1/7/01; no development.

P 2. 1/7/01; no development.

Q 1. 2/?; no development.

Q 2. 2/?; no development.

R 1. 3/2; no development.

R 2. 3/4; no development.

S 1. 4/6; no record.

S 2. 4/8; no record.

T. 5/5/01; no record.

U 1. 7/12/01; no record.

U 2. 7/14/01; no record.

(CC 11, P 16)

TABLE 101.

Zen. carolinensis (II-L 2); hatched 8/16/98; alive 5/7/01.

St. risoria (d); from dealer.

A 1. 5/6/99; apparently did not hatch.

A 2. 5/8/99; dead 6/3/99; at 12 da.

?B 1. 6/2; (sex ?); dead 1. 1/06; 7 mo.

B 2. 6/4; developed nearly to hatching.

♂ E 1. 9/5; dead 3/9/03 42 mo.

E 2. 9/7; alive 6/10/02; 33+ mo.

♂ II 1. 4/24/00; dead 2/28/02; 22 mo.

H 2. 4/26/00; dead (care) 21 da.

I 1. 5/31; hatched.

♂ I 2. 6/2; dead 3/1/02; 21 mo.

♂ J 1. 7/11; dead 5/30/02; 22½ mo.

J 2. 7/13; no development.

N 1. 12/7; not well cared for by foster parents.

N 2. 12/7; not well cared for by foster parents.

O 1. 1/22/01; no development.

♂ O 2. 1/24/01; dead (care ?) 3/2/01; at 6 wks.

P 1. 3/3; dead 4/1/01; at 4 wks.

P 2. 3/5; dead 4/3/01; at 4 wks.

C 1. 7/1; some development.

♂ C 2. 7/3; dead 2/10/03; 43 mo.

♂ D 1. 7/31; dead 12/25/99; 5 mo.

D 2. 8/2; a little development.

F 1. 11/15; no development.

F 2. 11/17; no development.

♂ K 1. 8/1; dead 12/11/00; 4 mo.

K 2. 8/3; probably not hatched.

L 1. 9/8; no development.

♂ L 2. 9/10; dead 11/25/02; 26½ mo.

M 1. 10/7; no development (good care ?).

M 2. 10/7; no development (good care ?).

Q 1. 4/5; weak shell, much development.

Q 2. 4/7; hatched.

R 1. 5/3; "died at a few days (care)."

R 2. 5/5; "died at a few days (care)."

(CC 6, A 14, P 16)

¹ Apparently the sex of this 7-months-old bird could not be ascertained.

TABLE 102.

σ^3 Zen. carolinensis (1-H 1); hatched 9/1/97; 11/4/01; 50 mo.
 φ St. risoria (C); from dealer March 1898.

A 1. 6/2/98; no development.	D 1. 7/21; no record; probably no development.
A 2. 6/4/98; no development.	D 2. 7/23; no record; probably no development.
B 1. 6/16; no development.	E 1. 7/31; no record; probably no development.
B 2. 6/18; no development.	E 2. 8/2; no record; probably no development.
C 1. 7/4; no development.	
σ^3 C 2. 7/6; hatched; dead 10/18/08 at 3½ mo. ¹ (Pair separated 8/16/98).	

φ St. risoria (E) given 5/1/99.

A 1. 5/12/99; no development.	B 1. 6/4; probably no development.
A 2. 5/14/99; no development.	B 2. 6/6; probably no development.

¹ "This hybrid was of a lighter and brighter brown than the other two obtained in same manner. They approached more the color of the male, while C 2 makes a greater advance towards the female. The general color of C above is a light reddish brown."

TABLE 103.

σ^3 Zen. carolinensis (1 ?); hatched 5/15/96; 3/17/97.
 φ risoria-alba hyb. (XW 2 B 1); hatched 5/30/96.

A 1. 3/7/97; no development.
A 2. 3/9/97; no development.

σ^3 Zen. carolinensis (2) given 3/17/97. ♀ had laid 1 egg 2 weeks before B 1 and B 2.

B 1. 3/23; no development) because no copulations of B 2. 3/25; no development)	pair.	C 1. 5/25; no development.
A 1. 4/8; 44 da. (see text); dead 5/22 (care ?).	D 1. 6/7; one developed near to hatching, other prob-	
A 2. 4/10; no development.	D 2. 6/9; ably no development.	
B 1. 5/7; not much development.	E 1. 7/1; no development.	
B 2. 5/9; no development.	E 2. 7/3; no development.	
F. 7/26; no development; probably no second egg.	G 1. 8/11; no development.	H 1. 8/24; no development.
	G 2. 8/13; no development.	H 2. 8/26; no development.
I 1. 2/24/98; J 1, K 1, L 1.	M 1. 4/10; laid without copulations.	N 1. 4/18; no development.
I 2. 2/26/98; J 2, K 2, L 2.	M 2. 4/12; laid without copulations.	N 2. 4/20; no development.
Copulations on and after 4/16/98.		
O 1. 4/30; no development.	T 1. 6/26; no development.	X 1. 4/10/99; no development.
O 2. 5/2; no development.	T 2. 6/28; no development.	X 2. 4/12/99; no development.
P 1. 5/17; no development.	U 1. 7/14; no development.	Y 1. 5/21; no development.
P 2. 5/19; no development.	U 2. 7/16; no development.	Y 2. 5/23; no development.
Q 1. 5/30; not tested.	V 1. 8/19; no development.	Z 1. 5/11; no development.
Q 2. 6/1; not tested.	V 2. 8/21; no development.	Z 2. 5/13; no development.
R 1. 6/7; no record.	(Some sets of eggs with male not sitting, until W).	AA 1. 5/30; no development.
R 2. 6/9; no record.	W. 11/1/98; no development.	AA 2. 6/1; no development.
S 1. 6/17; no development.		BB 1. 6/11; probably no development.
S 2. 6/19; no development.		BB 2. 6/13; probably no development.

TABLE 104.

Pair 1.

σ^3 Zen. carolinensis (1); hatched 1896; dead 8/?/99; 36 mo.

φ Alba-ris. \times ris.-alba (D 1); hatched 8/6/97; alive 7/25/99; 24+ mo.

A 1. 6/9/98; a little development.	D 1. 10/2; no development, but σ^3 not copulating.
σ^3 A 2. 6/11/98; hatched; dead 1/8/00; 19 mo.	D 2. 10/2; no development, but σ^3 not copulating.
B 1. 7/15; no development.	E 1. 11/5; sire copulates, but does not sit.
σ^3 B 2. 7/17; hatched; dead 12/10/00; 29 mo.	E 2. 11/7; sire copulates, but does not sit.
C 1. 8/6; about 7 day embryo.	F 1. 11/18; no record; probably no development.
C 2. 8/8; no development.	F 2. 11/20; no record; probably no development.

G 1. 4. 10/99; no development.
 G 2. 4/12/99; no development.

H 1. 4/22; one dead 11/4/01, at 30½ mo.; one developed,
 H 2. 4/24) failed.

I 1. 5/25; not much development.
 I 2. 5/27; dead 7/16/99; 7 wks.

J 1. 6/26; dead 7/21/99; 3½ wks.
 J 2. 6/28; dead 7/19/99; 3 wks.

K 1. 7/23; dead 8/16/99; 3 wks.
 K 2. 7/25; dead 8/16/99; 3 wks.

(C 7/22, P 16)

TABLE 104 (*continued*).

Pair 2.

σ^{α} <i>Zen. carolinensis</i> (4); hatched 9/16, 96.	
φ <i>Alba-ris. x ris-alba</i> hyb. (B 2).	
A 1. 4/12/98; not tested.	D 1. 6/3/98; no development.
A 2. 4/14/98; not tested.	D 2. 6/5/98; no development.
B 1. 4/20; soft shell.	E 1. 6/17; no development.
B 2. 4/22; soft shell.	E 2. 6/19; no development.
C 1. 5/9; no development.	F 1. 5/5/99; no development.
C 2. 5/11; no development.	F 2. 5/7/99; no development.

φ *Zen. carolinensis* (H-K 2); 7/5/98 given to above male, June 1899.

A 1. 7/24 99; hatched, no record.	B 1. 8/30; hatched, no record.
A 2. 7/26 99; hatched, no record.	B 2. 9/1; no trace of development. (CC 18)

TABLE 105.

σ^{β} *Zenaida* \times *Zenaidura* hyb. (ZZ 1); 4/10/05; 3/22/09; 47 mo.; 14 rectrices.

φ *St. risoria* (purity ?); age not recorded; 12 rectrices.

A 1. 5/1/08; no development.	
σ^{β} A 2. 5/3/08 ZZ-R 1	12 rectrices, 2 or 3 dull vestiges of spots (see pl. 20).
B 1. 5/31 ZZ-R 2	("down" more as in sire).
B 2. 6/2	"developed near to hatching, strength failed"; (complexion lighter than <i>Zenaida</i>).
C 1. 7/3 ZZ-R 3	12 rectrices; 3 traces of spots (tertials); dead 12/5/08 5 mo.
C 2. 7/5	developed some days, but failed to hatch.
σ^{β} D 1. 8/7 ZZ-R 4	dead 9/8/09 13 mo.
σ^{β} D 2. 8/9 ZZ-R 5	dead 9/14/09 13 mo.
E 1. 9/16 ZZ-R 6	14 rectrices, short as in <i>Zenaida</i> .
?E 2. 9/18 ZZ-R 7	12 rectrices ¹ dead 8/17/09 11 mo.

F 1. 1/1/09; failed to hatch.

F 2. 1/3/09; failed to hatch.

G 1. 2/13; hatched, thrown from nest; "strong looking," dark.

G 2. 2/15; nearly hatched (exposure); "strong looking," dark.

H 1. 2/23; hatched; thrown from nest, died.

H 2. 2/25 ZZ-R 8 12 rectrices.

(C 5)

¹ "Seems to be a male with two minute globular testes; am unable to be certain of their being testes."

TABLE 106.

σ^{β} *Zenaida* \times *Zenaidura* hyb. (ZZ 4); hatched 5/20/05; 9/13/09; 52 mo.

φ *St. alba* (93) (purity ?).

?A 1. 4/23/08 ZZ-A 1	dark; 14 rectrices; apparently no gonads ¹ 5/24/09 13 mo.
A 2. 4/25; developed, but died in shell about 24 hours before time to hatch.	
B 1. 5/23; no record, certainly not hatched.	
?B 2. 5/28 ZZ-A 2	dark; apparently no gonads ² 8/4/09 14½ mo.
C 1. 6/21; no development.	
C 2. 6/23; no development.	
D 1. 7/4 ZZ-A 3	dark, not quite as <i>Zenaida</i> ; 14 rectrices ³ 6/3/10 23 mo.
D 2. 7/6; no development.	
σ^{β} or σ^{β} φ E 1. 9/2 ZZ-A 4	alive 10/1/14 73+ mo.
E 2. 9/4 ZZ-A 5	dead or disappeared before 2/5, 11.

F 1. 5/19 (one=ZZ-A 6; no other record); other not hatched.

F 2. 5/21

G 1. 6/24; no development.

G 2. 6/26; no development.

H 1. 7/9; no development.

H 2. 7/11; no development. (CC 8)

¹ I find *no testicles, no ovary*. It may be that very obscure rudiments of sex-organs exist, but I can not distinguish anything of that kind."

² I find nothing that looks like testicles or ovary."

³ "A marginal chequer (spot) was found on the third tertial of each side, this not quite reaching middle of web and becoming thin and shadowy along inner boundary."

TABLE 107.

σ^{β} *Zenaida-Zenaidura* \times *Zenaida* \times *Zenaidura-Zenaida* (mutant) hyb. (2 Z-3 ZN 3); 8/1/09.

φ *Risoria-alba* \times *risoria-alba* (125).

A 1. 8/15/10 Z-ZNR 1	"one vestigial spot on tertial"; disappeared or dead before 2/5/11.
?A 2. 8/17/10 Z-ZNR 2	"no vestigial spot seen"; dead 10/25/14; <i>no gonads whatever</i> .

A 1. 9/1 ZNZ-RA 1

A 2. 9/3 ZNZ-RA 2

(EM 9, Misc. 2, XX 6)

B 1 and B 2 "laid about Nov. 5, 1910. Birds still sitting on them Nov. 20, but there is no development; fertility lowered at end of season" (italics are the author's).

BLOND AND WHITE RINGS CROSSED WITH COMMON PIGEONS.

The presentation of the data for crosses of the ring-doves with common pigeons may be prefaced by the following statement³ made in 1898 by the author:

Dr. Günther, of London, wrote me that he had succeeded in getting a few hybrids between the common dove (*C. laticauda*) and the so-called ring-dove (*St. risoria*) and that all the young which he obtained were males. He did not succeed in mating the hybrids with either of the parent species, and adds that they were so disagreeably noisy that his neighbors did not like to have them around; he therefore felt obliged to put them into the Zoological Garden, where they were kept for about 6 years. When the last one died a year or more ago, Dr. Günther kindly sent me the skins. These hybrids were obtained from a white fantail male and a female ring-dove, and apparently all had about the same color, approximating somewhat to the ground-color of the rock-pigeon. Günther mentions no case in which any white appears.

A word or two may be said as to what there is of interest in the study of these pigeon hybrids. One argument was drawn from hybrids a long time ago, namely, that they exhibit the *characters of both parents* and therefore disprove the old preformation doctrine of development. In other words the ovum can not be a preformed pigeon of a distinct species, because fertilization can turn it into something else. That argument has also been used against the more modern idea of preformation, which might perhaps be expressed by pre-organization,—not that adult organs are formed or present in the organism, but that the egg has an oriented organization with a head, so to speak, or with a region anticipating the head, and other regions anticipating other parts. It seems to me that in the study of hybrids we have a very excellent means of approaching the question of whether the egg really represents an organization to begin with. I have found a good many facts in embryology which led me to think strongly that the egg is really an oriented organism. I have found some very puzzling facts in my short experience with hybrids of pigeons.

There have been very diverse opinions offered as to what the hybrid really includes. Some have maintained that the hybrid includes all the characters of both parents. Naudin⁴ says: "A hybrid is a living mosaic work in which the eye can not distinguish the discordant elements, so completely are they intermingled." Darwin states that "it would be perhaps more correct to say that elements of both parents exist in every hybrid in a double developed state, namely, blended together and completely separate."

A brief extract from Darwin⁵ on the possibilities of establishing a new race by crossing is of interest:

"Until quite lately, cautious and experienced breeders, though not averse to a single infusion of foreign blood, were almost universally convinced that the attempt to establish a new race, intermediate between two widely distinct races, was hopeless; they clung with superstitious tenacity to the doctrine of purity of blood, believing it to be the ark in which alone true safety could be found. Nor was this conviction unreasonable; when two distinct races are crossed, the offspring of the first generation are generally nearly uniform in character; but even this sometimes fails to be the case, especially with crossed dogs and fowls, the young of which from the first are sometimes much diversified. As cross-bred animals are generally of large size and vigorous, they have been raised in great numbers for immediate consumption. But for breeding they are found to be utterly useless; for though they may be themselves uniform in character, when paired together they yield during many generations offspring astonishingly diversified. The breeder is driven to despair, and concludes that he will never form an intermediate race. But from the cases already given, and from others which

³ A stenographic report (slightly corrected by the author, and adapted by the editor) of part of a lecture to the Zoological Club, The University of Chicago, March 9, 1898.

⁴ Nouvelles Archives du Museum, tom. 1, p. 151.

⁵ Animals and Plants, Vol. II, p. 66.

have been recorded, it appears that patience alone is necessary. . . . Within recent times, as far as animals are concerned, the crossing of distinct species has done little or nothing in the formation or modification of our races. It is not known whether the species of silk-moth which have been recently crossed in France will yield permanent races. . . . Some authors believe that crossing is the chief cause of variability—that is, of the appearance of absolutely new characters. Some have gone so far as to look at it as the sole cause; but this conclusion is disproved by some of the facts given in the chapter on bud-variation. The belief that characters not present in either parent or in their ancestors frequently originate from crossing is doubtful."

I think that these quotations express the essentials of what we know about the results of hybridization. Darwin is quite decided in his opinion that it is very difficult to get anything in the hybrid which is not in the parent.

I have already stated that the hybrids which have hitherto been obtained in the case of pigeons are mainly those between the male common pigeon and the ring-dove. No one, so far as I know, has ever succeeded in getting the reciprocal hybrid; that is, the hybrid between the male ring-dove and the female of any of the common races. It is comparatively easy to mate a male common pigeon with the female ring-dove. The ring-dove is a quite small species (the reader may refer to pl. 8). A male homer, such as I now have mated with a ring-dove, would not from preference select a female of the ring-dove species, but the isolation of such a pair is usually all that is necessary to bring about the mating. In this case the male is much the stronger and the female makes no resistance; being much the weaker she would not offer to peck or strike. But when the attempt is made to effect a mating in the reverse order, using the small ring-dove as the male and set him to courting the very large female homer, the male meets with difficulties at once. There is no natural affinity between the two birds, and if the small male does not keep at a proper distance he is likely to be punished at once. After he has received a few blows on his head the male no longer wants to remain in the sight of such a large and offensive bird; he becomes timid and scarcely dares to approach her. Mating in this way, with a small male and a large female, is something so contrary to the common rules of nature that it becomes difficult. It is, however, not at all impossible when one takes it in hand and uses time and a few precautions. It is a very simple process to isolate the two birds and put them where they can not see their own species. At the time of mating pigeons do not know their own species unless it is presented to them. Allowing that the male has a cage of appropriate size, he gets into the habit of getting into the nest-box and calling for a mate. At that time the large female can be caught in one's hands and held up alongside the nest-box. The male will be a little afraid, but any blows with the beak or strokes with the wing can be prevented; and if this be repeated for a week or two, the male becomes accustomed to the sight of the large female and at length welcomes her. When it is clear that the female is ready to mate she can perhaps be trusted, especially if she shows any signs of fondling his head while being held in your hand; she can then be set free in the cage, and if the male keeps on calling she will probably go into the nest-box and the match is practically completed. But all this would not happen in a state of nature.

Of the difficulties of getting these hybrids I want to say just a word further. From one pair beginning May 3, 1896, and ending August 23, 1897, I had 41 eggs and raised only 4 males; only 7 birds hatched; only 14 were fertilized. You can not get enormous numbers of hybrids from the ring-dove and the common pigeon. I have kept a fantail mated with a ring for more than a year and got only 1 bird. This was a white male with 13 feathers in his tail; the father's influence gave one additional feather to the tail of the young. A homer mated for 6 months with a ring-dove supplied but 2 specimens, both males. Only a year ago I succeeded in getting a male *alba-risoria* hybrid mated with a female homer (*C. tabellaris*). The mating was accomplished some time in April (1897), and I got eggs shortly

after with no results. I got eggs again, and from either the second or the third clutch I found that one egg was fertilized;⁶ but about that time I was obliged to travel to Woods Hole and in transit lost the egg. I got more eggs in the summer, some of which were fertilized, and in which development ran on for several days. Some of these seemed very promising, but it all came to naught. Through the entire summer the infertility or degree of development grew worse and worse, until I failed completely to get eggs fertilized at all. I kept the pair to see what the result would be another year, knowing that the possibilities of fertilization are less during the latter part of the season than they are at the beginning. This year (1898) I have already had the good fortune to get two hybrids from this pair. (A 1)

The crosses of ring-doves with common pigeons represent a wider cross than that described in the preceding section of this chapter—family differences here instead of subfamily distinction there. The present records for the wider cross show a decidedly greater amount of infertility than was noted in the earlier series, and correspondingly only males result from these matings, except, as already noted, in two matings (tables 116 and 117) involving a hybrid male parent and a female homer which was possibly a mongrel. Restricted life-terms and abnormalities also reappear in this wide cross. The breeds of common pigeons used for these crosses were the archangel, *admista*, fantail, tumbler, and homer. The records have been grouped in this order and the tabulations given with a minimum of discussion.

Archangel × *ring*.—Tables 108 and 109 present the results of the mating of a male archangel with 6 different females. This bird was almost fully fertile with a related breed, *C. gyrans*; only about one-fourth of the eggs of the 2 pure *St. risoria* (*D 1* and *D 2*) showed any development; 6 tests with another (weak, see below) pure ring (*GF 1*) proved entirely infertile, as did 6 tests with *alba* (*W 2*) and 4 tests with an *alba* × *risoria* hybrid.

Admista × *ring*.—One of the blond ring females (*D 2*) which was mated with the archangel (*Ar 1*) was previously twice tested with another common pigeon. With the archangel only 5 of 21 eggs showed any development whatever; 3 hatched, 2 lived 9 to 11 days. With the two other common pigeons she gave a somewhat better result, though still a poor one, as is shown in table 110.

Fantail × *ring*.—The record presented in table 111 shows how little fertile is the widely separated cross *C. laticauda* × *St. risoria*. The small but perceptible influence of the male on the number of tail-feathers (rectrices) in the two hatchets (of 44 tests) is of interest. The sire had 19 rectrices, the dam 12. One of the young had 14 tail-feathers—a feather added to each side. The other young had 13, the extra feather being added to the center of the tail. The first young lived only 3 weeks, but “the second hybrid (*K 1*) hatched December 1, 1897 (still alive March 6, 1909),⁷ with 13 tail feathers, and with a slight tilting of the middle feathers. All of these tail-feathers were colored; but when the bird became about 10 years old (1907-8) three of its tail feathers became white in course of molt. The original rectrices were recorded, the color noted, and the feathers plucked and mounted. I still have the mount, but it has been damaged by moths. In 1908 I again plucked and mounted the tail feathers; I have a photograph of the bird and another of the mounted tail.

⁶ After 3 or 4 days of incubation one can readily learn whether an egg has a living and developing young by holding it up to the light.

⁷ Before noting that this was a pedigree bird it was killed April 5, 1914. It was then healthy and vigorous, though more than 16 years old. Birds of the mother's species—*St. risoria*—probably never live even 10 years. When 2 years old this bird was fertile with a tumbler (see table 113).—EDITOR.

"This is a case where white came in as a result of weakness, due probably to age and possibly to tuberculosis, one joint of the leg being somewhat affected. The extra tail feathers do not represent so many independent elements given by the male, but rather an excess of energy of development manifested at the same region as in the male parent. The sire had 19 tail feathers." (SS 3)

TABLE 108.

 σ^a C. illyrica (ArI). φ St. risoria (D 1); 7/1/95; escaped 10/25/97.

A 1. 2/18/97; hatched, dead 1 day (cold).	E 1. 5/11; probably no development.
A 2. 2/20/97; developed; broken.	E 2. 5/13; probably no development.
B 1. 3/14; no development.	F 1. 6/6; no development.
B 2. 3. 16; some development.	F 2. 6. 8; no development.
C. 4/6; no development.	G 1. 6. 26; no development.
D. 4/29; probably no development.	G 2. 6. 28; no development.
H 1. 7/12; no development.	J 1. 8/29; no development.
H 2. 7/14; no development.	J 2. 8/31; no development.
I 1. 8/2; hatched; dead 3½ days.	K. 10/23; probably no development.
I 2. 8/4; pricked shell; failed.	

(C 7/28)

φ St. risoria (GF 1) given about Nov. 1897. Six eggs were produced 12/10/97 to 1/18/98; all proving infertile. This was apparently a "weak" bird, since the records (C 7/20) show she was killed on 1/27/98.—EDITOR.

On 1/21/98 another φ risoria (D 2) given, with following result:

A 1. 1/28/98	one developed, failed; other probably no	G 1. 7/18; no development.
A 2. 1/30/98	/ development.	G 2. 7/20; no development.
B 1. 2/19; pricked shell, failed.		H 1. 8/12; no development.
B 2. 2/21; no development.		H 2. 8/14; no development.
C 1. 3/16; no development.		I 1. 8/24; no development.
C 2. 3. 18; no development.		I 2. 8/26; no development.
D 1. 4/14; developed 8 to 10 days.		J 1. 9/11; no development.
D 2. 4/16; no development.		J 2. 9/16; no development.
E 1. 5/12; hatched; dead at 11 days.		K 1. 10/5; no development.
E 2. 5/14; no development.		K 2. 10/7; no development.

 σ^a F. 6/11; hatched.

(C 7/28)

φ St. alba (W 2) given 10/16/98; between this date and December 4, 1899, 6 eggs were produced and all tested absolutely infertile.

 φ risoria \times alba hybrid was substituted early in 1899, and produced 4 infertile eggs with this male.

TABLE 109.

 σ^a C. illyrica (ArI) [before with risoria (D 1, GF 1, D 2); alba (W 2); and ris.-alba hyb.] φ C. gyranus; black parlor tumbler.

A 1. 7/28/99; hatched.	F 1. 2/28; hatched; soon died.
A 2. 7/30/99; hatched.	F 2. 3/2; hatched; soon died.
B 1. 9/13; not tested.	G 1. 3/31; did not hatch.
B 2. 9/15; not tested.	G 2. 4/2; hatched.
C 1. 10/8; hatched; died 8 to 10 days.	H 1. 6/7; not tested.
C 2. 10/10; pricked shell, failed.	H 2. 6/9; not tested.
D 1. 11/22; hatched; soon died.	I 1. 7/9; probably not tested.
D 2. 11/24; hatched; soon died.	I 2. 7/11; probably not tested.
E 1. 1/17; no record.	J 1. 8/19; hatched.
E 2. 1/19; no record.	J 2. 8/21; probably hatched.

(C 7/28)

Tumbler \times ring.—The very distantly related tumbler pigeon (*C. gyranus*) and the blond ring-dove yield only male offspring (table 112). With a female *risoria \times alba* hybrid the result was the same, as will be seen in table 114. It will be noted that the amount of absolute infertility in both cases is very great. The distribution of this infertility is of interest in reflecting the influence of "overwork" and lateness of season. The greater developmental power of the first eggs of clutches (except the very first of the season), as compared with the

second, is also well shown when the eggs of the pure species are used. This latter situation is *not true of eggs produced by the hybrid risoria × alba*. In the mating of the tumbler with a pure ring the first egg shows greater developmental power in 6 cases, less in 2 cases; and both of these two exceptions pertain to the first clutch of the year. On the other hand, when the same tumbler was mated to a *risoria × alba* hybrid the second egg of the clutch showed greater developmental power in 5 cases and less developmental power in 3 cases.

The difficulty of getting hybrids from wide crosses and the added difficulty which arises when either of the members of the cross is itself a *hybrid* is illustrated in the record (table 113) of a *laticauda × risoria* male to a female tumbler. Only 3 eggs of 24 tested showed any development. These eggs were from adjacent clutches of early June and middle July and all were hatched. The second egg of the latter clutch was the egg that failed.

Homer × ring.—A mating between a male blond ring and a female homer yielded 40 eggs (from October 1898 to March 1900, data not tabulated), 35 of which were tested; 1 hatched, 1 developed to hatching and failed; 1 produced a 13-day embryo, while a fourth egg developed a small embryo. The male was later found to be fully fertile with ring-doves, but infertile with a female Chinese turtle-dove (*Sp. chinensis*). (X 10, X 4)

TABLE 110.

Pair 1.

♂ C. admista (Z); 1891 or 1895 (?) ; weight 368 grams.
♀ St. risoria (D 2); 7/2/95; weight 163 grams.

A 1. 5/3/96; no development.	♂ L 1. 12/20; hatched; ² dead 6/28/02.
A 2. 5/5/96; no development.	L 2. 12/22; no record.
♂ B 1. 5/23; hatched; dead at 6 days.	M 1. 1/23/97; no development.
B 2. 5/25; much development (killed by trip ?).	♂ M 2. 1/25/97; (2) hatched; ³ dead 6/28/02.
C 1. 6/19; failed to hatch.	N 1. 1/26; developed 7 day embryo.
C 2. 6/21; failed to hatch.	N 2. 2/28; fully developed; killed.
D 1. 7/1; did not hatch.	♂ O 1. 3/19; hatched; uniform gray.
D 2. 7/3; did not hatch.	O 2. 3/21; (3) no development.
E 1. 7/20; no development.	P 1. 4/17; nearly full development.
E 2. 7/22; no development.	P 2. 4/19; nearly full development.
F 1. 8/2; about 7 day embryo.	Q 1. 5/16; no development.
F 2. 8/4; some development.	Q 2. 5/18; no development.
G 1. 8/24; no development.	R 1. 5/30; no development.
G 2. 8/26; no development.	R 2. 6/1; developed but did not hatch.
H. 9/11; no development.	S 1. 6/20; developed but did not hatch.
I 1. 10/11; no development.	S 2. 6/22; no development.
I 2. 10/13; no development.	♂ T 1. 7/12; (4) hatched; alive 6/29/02.
J 1. 10/31; some development.	T 2. 7/14; hatched; dead at 5 days.
♂ J 2. 11/2; hatched; ¹ dead at 28 days.	U 1. 8/22; no development.
K 1. 11/30; 3 to 5 day embryo.	U 2. 8/23; soft shell, broken.
K 2. 12/2; no development.	(F 29, A 14)

¹ "This bird has only 11 tail feathers."² "White spots on side of head; three white quills in right wing and one in left wing."³ "Has a white face; unlike eyes."

Pair 2.

♂ Common pigeon; color pure white and with a small crest.
♀ St. risoria (D 2); 7/2/95.

O 1. 10/26/97	one developed, broken; other, no record.	B 1. 12/21; some development.
O 2. 10/28/97		B 2. 12/23; some development.
A 1. 11/10/97; no development.		C 1. 1/12/98; developed, failed.
A 2. 11/12/97; hatched, dead 6 days (feeding ?).		C 2. 1/14/98; hatched. (C 7/30)

The reciprocal of this cross, namely, a male homer and a female ring-dove, was more successful. The result of a mating made 18 months before the beginning of the cross just described is detailed in table 115. From this mating 10 of the 13

eggs tested were hatched. But the homer here used as sire was a (*Hom.*, 1) bird whose remarkably high fertility has already been described in Chapter IX. It will here be noted, however, that the life-term of the offspring is quite short and that the young die suddenly without previous signs of illness.

From 34 tested eggs of a female common pigeon of unknown origin but considered a homer, mated to a male *alba-risoria* hybrid, 6 young were hatched, as shown in table 116. It is notable that the 2 young from this cross whose sex was recorded were classed as females (there is no record of autopsy of either of these birds; see below). This case would seem to constitute a violation of the rule that males only arise from family crosses unless the possible hybridization of the female parent be considered of importance. During 1897, when this sire was immature, 20 of the above-mentioned 34 eggs were laid, and only 2 of these showed even the beginnings of development (7 to 10 day embryos).

Later 91 eggs of this same stray common pigeon (*Hom.*, 4) were laid while mated to another male F_2 hybrid (*alba-risoria* \times *risoria-alba*, E 2). The result is fully given in table 117. Only 11 birds were hatched from this large number of eggs. The seasonal distribution of color in these offspring is of some interest. 3 birds from the early and best part of the season were quite dark ("much brown"); 3 birds from late in the season were of light color, 1 being "light" and 2 "very light." There was 1 bird recorded as a female among these young.

From these two matings of hybrid ring-dove males with a stray female homer (?), it has been noted that both male and female young were apparently obtained; the female parent was, however, a "stray bird," and although a homer in appearance, may have been a hybrid from a cross with at least another domestic variety. The question of greater importance is, as briefly indicated at the beginning of this chapter, were these offspring birds really females? Neither of them seems to have laid eggs. Two of the three copulated as females and accepted males as mates, but during more than 12 months of such mating were positively known to have produced no eggs. The editor is convinced that the author classified at least 2 of these 3 birds on the basis of their sex-behavior (they were obtained at the beginning of his hybridization studies), and that, in the light of later work, it is very questionable whether these birds bore ovaries. The term of life of the offspring of these two matings is not long, and 2 (or 3) of the 17 young were notably deformed.

In the final mating of this series the male is a bigeneric hybrid (*T. orientalis* \times *St. risoria*) and the female is a homer. The very restricted fertility of the pair is made clear by reference to table 118. It is when fertility is very low, as in this case, that the differences between the developmental capacities of various germs are best shown, and here, too, that "seasonal" differences are the more readily detected. The following statement is found concerning the results of this mating:

Male OS 1 and the female homer again have developing eggs (March 19, 1909). They previously hatched 1 young at the beginning of the season (see record). Here is another proof of greater strength at the start, at the first of the season.

On July 13 (1909), OS 1 and the homer again have 2 eggs fertilized, but fail to carry out development. These two eggs, laid July 1 and 3, furnish a *good case of weakness of development in the egg*. One developed for 5 to 6 days. The other developed up to making the first puncture of the shell on July 18. The puncture was open for a space of about 3 to

4 mm., but the bird was dead; it had evidently failed to take the next step onward. I opened the shell and found a good-sized bird, with yolk all absorbed except for a remnant that still projected. The down was pale and rather spare; the beak was pale, with a strong black bar.

I have had cases from these same birds and from others in which the young failed to make a puncture, but had developed to the point when the puncture should have and would have been made had the bird been strong enough to go on. Development, then, in these hybrid fertilizations presents numerous evidences of developmental strength in all degrees. (R 16)

Fertilization is of every degree, and results therefore in simple penetration of sperm which fails to make more than an early beginning of development or nothing at all, or it may give stages of cleavage, etc., up to blood-formation, and from this point it may go on and stop after forming an embryo at any point up to hatching; and when hatched, the fate is not yet settled; the bird may be deformed and still live, it may be too weak to develop further, or go on and die at 3, 4, 5, 6, or more days. All along the line we see that development requires energy, and stops or goes wrong for failure in this.

The male jungle-fowls develop more *rapidly* and *longer* than do female jungle-fowls.

Young birds often make failures. Doves reach the highest point at 3 to 4 years. They sometimes sit without laying when *young*, and also when *old*. (WW 1)

TABLE III.

♂ *C. laticauda*; from dealer 1896; white; 19 feathers in tail; stolen 7/12/98.

♀ *St. risoria* (B); 4/21/95; 12 feathers in tail; stolen 7/12/98.

A 1. 8/25/96; no development.	B 1. 5/9; no development.
A 2. 8/27/96; pricked shell, failed.	B 2. 5/11; no development.
B 1. 9/18; developed; broken.	C 1. 5/31; developed; killed.
B 2. 9/20; developed; broken.	C 2. 6/2; pricked shell, failed, much yolk.
C 1. 10/6; no development.	D 1. 6/22; developed, lost (trip).
C 2. 10/8; no development.	D 2. 6/24; developed, lost (trip).
D 1. 11/15; no development.	E 1. 7/12; no development.
D 2. 11/17; no development.	E 2. 7/14; no development.
E 1. 11/30; no development.	F 1. 7/31; no development.
E 2. 12/2; no development.	F 2. 8/2; no development.
F. 12/21; thin shell.	G 1. 8/13; no development.
G 1. 12/31; probably no development.	G 2. 8/15; no development.
G 2. 1/2; probably no development.	H 1. 8/23; no development.
H 1. 2/14/97; probably no development.	H 2. 8/25; no development.
H 2. 2/16/97; probably no development.	I 1. 10/7; developed near to hatching.
I 1. 3/12; probably no development.	I 2. 10/9; developed near to hatching.
I 2. 3/14; probably no development.	J 1. 11/1; did not hatch.
J 1. 3/22; no record.	J 2. 11/3; did not hatch.
J 2. 3/24; no record.	K 1. 11/15; hatched; white flecks. ²
K 1. 4/5; no development.	K 2. 11/17; no embryo.
K 2. 4/7; no development.	L 1. 12/15; developed only a blood circle.
A 1. 4/17; no development.	L 2. 12/17; no development.
A 2. 4/19; hatched; dead ¹ at 3 weeks; brown; 14 feathers in tail.	M 1. 1/16/98; no development.
	M 2. 1/18/98; no development.

(SS 3)

¹"I can not account for the death of this bird; it was a very large specimen and very thrifty till the day before it died, when it refused to eat; towards night it breathed slowly and with some difficulty. The tail of this hybrid had 14 feathers."

²"K 1 is marked with white, this being speckled in on the crown and occiput, beginning on a line running over the head from eye to eye. On each side the broken white flecks run just over and behind the eyes—a sort of streak of flecks. The rump also is marked with white in an odd way; the patch of white is here median, but at the base of the tail it is extended clear across the body. There are 13 tail feathers; the three middle feathers are brownish gray; the extra feather is thus a middle one." This bird was killed by the editor, before realizing that it bore a tag, on April 5, 1914. It was then more than 16 years of age. "In 1907-8 this bird acquired 3 white tail feathers."

TABLE II2.

σ^3 C. gyrans (T 3); black Japanese tumbler (13 tail feathers).		
φ St. risoria (L 1); dead 12/20/99.		
A 1. 7/23/97; no development.	C 1. 9/26; lost.	σ^3 E 1. 10/21; hatched.
σ^3 A 2. 7/25/97; hatched.	C 2. 9/28; lost.	E 2. 10/23; no development.
σ^3 B 1. 8/25; hatched.	D 1. 10/10; no development.	F 1. 12/13; hatched.
B 2. 8. 27; alive at time to hatch.	D 2. 10. 12; no development.	σ^3 F 2. 12/15; hatched.
G 1. 1/20/98; pricked shell; failed.	K 1. 6/4; no development.	O 1. 9/8; no development.
G 2. 1/22/98; hatched.	K 2. 6/6; no development.	O 2. 9/10; no development.
σ^3 H 1. 2/19; hatched.	σ^3 L 1. 6/23; hatched.	P 1. 10/1; no development.
H 2. 2/21; alive, immat. opened.	L 2. 6/25; some development.	P 2. 10/3; no development.
I 1. 4/1; hatched.	M 1. 7/24; no development.	Q 1. 11/1; no development.
I 2. 4/3; no development.	M 2. 7/26; no development.	Q 2. 11/3; no development.
σ^3 {J 1. 5/19} one hatched, other failed.	N 1. 8/18; no development.	R 1. 12/?; slight development.
{J 2. 5. 21}	N 2. 8/20; no development.	R 2. 12/?; no development.
S 1. 1/16/99; no development.	W 1. 5/3; no development.	AA 1. 8/12; no development.
S 2. 1/18/99; no development.	W 2. 5/5; no development.	AA 2. 8/14; no development.
T 1. 2/24; no development.	X 1. 6/3; no development.	BB 1. 10/5; no development.
T 2. 2/26; no development.	X 2. 6/5; no development.	BB 2. 10/7; no development.
U 1. 3/26; no development.	Y 1. 6/30; no development.	CC 1. 10/23; no development.
U 2. 3/28; no development.	Y 2. 7/2; no development.	CC 2. 10/25; no development.
V 1. 4/14; no development.	Z 1. 7/22; no development.	DD 1. 11/21; no record.
V 2. 4/16; no development.	Z 2. 7/24; no development.	DD 2. 11. 23; no record. (X 1, A 14)

TABLE II3.

σ^3 laticauda \times risoria hyb. (K 1).		
φ C. gyrans (T 1); brown tumbler.		
A 1. 6/4/98; no development.	E 1. 9/12/98; no development.	I 1. 6/7; hatched (killed, 8 weeks).
A 2. 6/6/98; no development.	E 2. 9/14/98; no development.	I 2. 6. 9; hatched (dead, 2 weeks).
B 1. 7/?; no development.	F 1. 10/6; no development.	J 1. 7/19; hatched (no record).
B 2. 7/7; no development.	F 2. 10/8; no development.	J 2. 7/21; no development.
C 1. 7/28; no development.	G 1. 11/4; no development.	K 1. 8/18; no development.
C 2. 7/30; no development.	G 2. 11/6; no development.	K 2. 8/20; no development.
D 1. 8. 23; no development.	H 1. 5/30/99; no development.	L 1. 9/5; no development.
D 2. 8. 25; no development.	H 2. 6/1/99; no development.	L 2. 9/7; no development.
	M. 9/15; no record; probably no second egg.	(X 3)

TABLE II4.

σ^3 C. gyrans (T 3); black Japanese tumbler (13 tail feathers).		
φ risoria \times alba hyb. (XW 2 D 1); dark color.		
A 1. 3/22/00} one failed; one hatched; very small; color	I 1. 1/1/01; no development.	
A 2. 3/24/00} gray with black.	I 2. 1/3/01; no development.	
B 1. 4/24; no development.	J 1. 1/17; no development.	
B 2. 4/26; no development.	J 2. 1/19; no development.	
C 1. 5/26; no development.	K 1. 2/14} one thin shell; other some development.	
σ^3 C 2. 5/28; hatched; blackish.	K 2. 2/16} .	
σ^3 D 1. 7/5; hatched; brownish-black.	L 1. 4/8; probably no development.	
D 2. 7/7; no development.	σ^3 L 2. 4/10; hatched.	
E 1. 8/10; no development.	M 1. 5/20} one hatched; dark gray.	
E 2. 8/12; hatched.	M 2. 5/22} .	
σ^3 F 1. 9/7; hatched.	N 1. 7/7; no development.	
σ^3 F 2. 9/9; hatched.	σ^3 N 2. 7/9; hatched; (has 13 rectrices, blackish).	
G 1. 10/28; no development.	O 1. 8/10; hatched.	
σ^3 G 2. 10/30; hatched; dove gray.	O 2. 8/12; (1) hatched; blackish.	
H 1. 12/14; no development.	P 1 and P 2; laid (1901) but no record.	
H 2. 12/16; no development.	Q 1 and Q 2; laid (1901) but no record.	

TABLE 114 (*continued*).

P 1.	2/28. 02; no development.	V 1.	2/6/03; broken.
P 2.	2/30 02; no development.	V 2.	2/8/03; broken.
Q 1.	4/2; no development.	W 1.	2/27; some development.
Q 2.	4/4; no development.	W 2.	3/1; some development.
♂ (R 1. 5/13)	one hatched; one failed.	X 1.	4/7; probably no development.
(R 2. 5/15)		X 2.	4/9; probably no development.
S 1.	6/26; probably no development.	Y 1.	5/29; one developed; other, probably no development.
S 2.	6/28; probably no development.	Y 2.	5/31
♀ T 1.	7/20; hatched; gray, to brownish gray.	Z 1.	7/5; no record.
T 2.	7/22; some development.	Z 2.	7/7; no record.
♂ U 1.	12/26; hatched; brownish black		
U 2.	12/28; probably no development.		

(X 1, A 14)

TABLE 115.

♂ C. tabellaria (Hom. 1); from fancier Feb. 1897 (2+ years old); killed 1902.

♀ St. risoria (M 2); 6' 20' 96.

A 1.	3/11/97; hatched.
A 2.	3/13/97; hatched; dead at 6 days; healthy till day before death.
B 1.	4/10; did not hatch.
B 2.	4/12; did not hatch.
C 1.	4/30; hatched; dead at 11 days; healthy till day of death.
C 2.	5/2; hatched; dead at 13 days; healthy till day of death.

♀ St. risoria (F) given (Hom. 1) on 6/2/97

♂ A 1.	6/5; hatched; probably died early.
♂ A 2.	6/7; hatched; dead (on journey) at 13 days.
B 1.	7/15; hatched; probably died early.
B 2.	7/17; relieved alive 1 day after time to hatch; immature, died.
C 1.	8/13; hatched; killed (accident).
C 2.	8/15; did not hatch.
D.	9/5; hatched; dead at 16 days; uniform pale gray, with a tinge of isabelline above, on edge of scapulars, coverts, etc.

(BB 5)

TABLE 116.

♂ alba × risoria hyb. (WD 1 H 2); 11/5/96 (light brown).

♀ C. tabellaria (?) (4); stray bird; considered a homer, but origin unknown.

J.	(1).	hatched 1/27/98.	gray.....	stands awkwardly erect; 12 tail feathers.
K.	(2).	hatched 2/28/98.	light gray.....	(some brown); 11 rectrices....., dead 6/28/02.
? ♀ M 1.	(3).	hatched 4/27/98.	strong tinge isabelline (brown).....	....., dead 6/30/02.
? ♀ N 1.	(4).	hatched 5/31/98.	white.....	(creamy on neck and breast).
O 1.	(5).	hatched 6/29/98.	.....	alive July '99; mated.
O 2.	.....	.....	.....	developed to hatching; failed.
P 1.	(6).	hatched 7/27/98.	.....	alive July '99; mated.
P 2.	.....	.....	.....	no development.
Q 1.	etc.	no development.	.....
Q 2.	etc.	no development.	.....

(A 14, X 2)

1. The long list of earlier eggs, almost all completely infertile, is omitted. These eggs (of 1897) were laid when the sire was perhaps not fully mature. *M 1*, listed here as female, was probably such in behavior only; see table 52, pair 12.—EDITOR.

TABLE 117.

♂ alba-risoria × risoria-alba (E 2); hatched 10/6/97; alive 10/23/04 (see pl. 25).

♀ C. tabellaria (?) (4); same as table 116; stray bird (origin unknown).

H 1.	.....	hatched 9/22/99; no other record.	
O 1.	.....	hatched (1900), but died early (exposure ?)	
R.	(3)	hatched 7/27/00; no other record.	
? S 2.	.....	hatched 10/2/00.....	....., very light; short legs; dead 6/7/01 (no statement on gonads).—ED.
♂ U 1.	.....	hatched 11/28/00.....	....., dead 12/10/00.
EE.	(1).	hatched 8/30/01.....	....., very light (almost like ring-dove).
II.	.....	hatched 9/2/02.....	....., dead (exposure ?) at 16 days.
JJ 2.	(2).	hatched 10/26/02.....	....., light....., leg broken, killed; sex ? 9/26/03.
LL.	(4).	hatched 3/4/03.....	....., much brown in first feathers.
OO 1.	(5).	hatched 5/31/03.....	....., much brown....., dead 12/3/04.
OO 2.	(6).	hatched 6/1/03.....	....., much brown in first feathers.

(A 14, X 2)

1. The clutches and eggs not recorded here were completely infertile.—EDITOR.

TABLE IIIS.

δ^3 orientalis \times risoria hyb. (1); 5/8 '01; stolen 7/19/12; 8 + yr. (see pl. 13).

♀ C. tabellaria (prob. 3 + yrs. old); color very pale, with two pale bars.

A 1. 5/2/07.....	.....hatched ¹.....color of homer.....	alive 9/20, 09.....	.....2½ + yr.
A 2. 5/4/07; no development.			

B. 2/7/08; no development.

"Birds laid many eggs here; no development, or just a suspicion of a beginning of development."

B 1. 12/14; no development.

B 2. 12/16; no development.

C 1. 1/15/09; no development.	D 1. 3 1; no development.	E 1. 3/15; some development.
C 2. 1/17/09; no development.	D 2. 3, 3; no development.	E 2. 3/17; some development.
F 1. May; no record.		G 1. 6/15; developed a blood circle.
F 2. May; no record.		G 2. 6/17; developed a blood circle.

H 1. 7/1) one developed for 5 or 6 days; other punctured a hole in shell and died.
H 2. 7/3)

δ^3 I 1. 8/1.....hatched².....dead 4/17/12.....32 mo.
I 2. 8/3; "a trace of development but not enough to give an embryo."

? J 1. 4/20/10; died 10/26/10. "I could find neither male nor female organs."

J 2. 4/22/10; no development.

K 1. 6/4; no development. L 1. 6/23; no development. M 1. 8, 29; no development.
K 2. 6/6; broken. L 2. 6/25; no development. M 2. 8/31; no development. (F 1)

¹ "This is not a really strong bird; he never spreads his tail in flight and shows, till now (9/20/09), no desire to mate."

² "The male parent is now 5 years old and is apparently at his best; the female is also (probably) about 5 years old."

BLOND AND WHITE RINGS CROSSED WITH THE EUROPEAN TURTLE-DOVE AND ITS COMPLEX HYBRIDS.

The formation of a series of complex hybrids was begun by crossing a single European turtle-dove (*Turtur turtur*) female (B 1) with an F_2 *alba-risoria* hybrid. The resulting offspring are thus trispecific and bigeneric hybrids. These hybrids were back-crossed to each of the three parent species, and the resulting hybrids were variously back-crossed and inbred; one was out-crossed with a fourth species, *St. humilis*. That this extent of breeding was possible is evidence that these crosses of *species* and *genera*⁸ were more fertile than the two groups of crosses (involving *subfamily* and *family* crosses) hitherto considered in this chapter. The high degree of complexity of the hybrids and the inbreeding involved are, at the same time, however, a guarantee of a restricted fertility and of a progeny not strong. The records bring out both of these points. There is much infertility in all of the matings and in only a single case is an offspring known to have lived as long as the individuals of the shortest-lived of the parent species normally live.

Much of this crossing was done as a means of determining whether and to what extent "characters are divisible." The color data are tabulated, therefore, in many cases as fully as they were recorded. A discussion of the data on the divisibility of characters is separately given in Chapter XVII, and only the data on fertility and sex, together with a proper identification of the crosses, require treatment here. These three latter topics will be considered together.

A turtle-dove female was crossed with an *alba-risoria* \times *risoria-alba* male, and, from this pair 7 of 12 tested eggs hatched (table 119). Three of the sons (δ D 1, δ G, and δ J 1) and one daughter (D 2) were mated back to ring-doves; two sons and the daughter with blond and white ring-doves. It will be noted that in the first cross color is sex-limited in its inheritance. The males are darker than the females, the dam is darker than the sire. This same association of sex and color seems also to obtain when this same turtle-dove was mated (table 120) to a grandson (through *St. risoria*).

⁸ The proper basis for a comparison of the generic and subfamily crosses was noted at the beginning of this chapter.—EDITOR.

Further breeding of the three sons and the daughter from the first cross was carried out as follows:

Male *D 1* was mated during two years with a blond ring (table 121), and during another two years with a white ring (table 122). It might seem from a comparison of the two records that, although there is much infertility throughout, this male was more fertile with one of the parent species (*alba*) than with the other (*risoria*). The known value of age in relation to fertility, and the lack of this data for the female *alba*, preclude such a conclusion. It is, however, of considerable interest to note that the offspring of *D 1* and the weaker¹ of these two species (*alba*) are nearly all females. Only 1 male was found among the 9 young whose sex was ascertained. Two of the young from the mating with the blond ring are shown in pls. 37 and 38; one from the mating with *alba* in pl. 38.

The second male (*alba-risoria-turtur* hybrid *G*) was nearly fully fertile with *risoria*, development failing only in the first and last 2 eggs of the first season, and falling a little short only in the second and third of the 10 eggs of the following season. But when mated to his daughter 5 of their 6 eggs failed to hatch. When a hybrid carrying still a different species was offered very little development was possible, and this was found in the first pair of eggs of the season (table 123).

Two of the young of this trispecific \times *risoria* cross were tested for fertility. These were both males, 1 being light (*B 2*) and 1 dark (*C 2*) in color. *B 2* mated to a pure blond produced (July) 2 eggs unable to hatch, followed by a pair (August) that produced 2 young that lived at least till they had adult plumage. The first of these was a male with the color of a blond ring-dove; the second was similar, but more clearly showed the reddish color of *turtur*, her parental grandmother. The result of the mating of *C 2* with a *humilis-risoria* hybrid, the entrance of a fourth species into this cross, is given in table 124. The two offspring are both females and have the composition: $\frac{1}{4}$ *alba*, $\frac{1}{4}$ *risoria*, $\frac{1}{4}$ *turtur*, $\frac{1}{4}$ *humilis*.

The third (*J 1*) of the tested brothers—from the original cross with *T. turtur*—was mated with the same blond ring previously mated and found fairly fertile with another brother (*G*). Fertility was here much restricted, as may be seen by reference to the bottom row of table 123.

We have thus presented the record of 3 trispecific hybrid brothers back-crossed to a *risoria* female. One of the sisters (*D 2*), a sister from the same clutch as *D 1*, was back-crossed to an *alba* male, and the data are presented in table 125. Three different males were tested with this female (*D 2*), and the several records make clear the low degree of fertility of this female trispecific hybrid. With hybrids related to her the infertility was absolute. With pure *risoria* she was, like her 3 brothers, at least partially fertile.

TABLE 119.

δ^3 *alba-ris.* \times *ris.-alba* hyb. (*D 2*); 8/27/97; brown (lighter color than mate).
 ♀ *T. turtur* (*B 1*); 4/29/99; alive July 1903; (darker than mate).

A. 3/22/00; soft shell.	♀ F 1. 5/30; very light, dead 9/19/04. F 2. 6/1; no development.
B 1. 3/30; thin shell; removed. B 2. 4/1; thin shell; broken.	δ^3 G. 7/1; color dark as D 1. H 1. 8/1; no development. H 2. 8/3; died autumn 1900.
C 1. 4/9; no record. C 2. 4/11; no record.	I. 4/23/01; thin shell. δ^3 J 1. 4/30; dark color, killed 2/4/05. J 2. 5/2; no development.
δ^3 D 1. 4/20; darker than D 2; alive 2/11/05. ♀ D 2. 4/22; light; pale centers to feathers.	K 1. 7/9; no development. K 2. 7/11; no development.
♀ E 1. 5/24; very light; dead 7/24/00. E 2. 5/26; from perch, broken.	(DD 4, C)

¹ See Chapter XV.

TABLE I20.

♂ trispecific × <i>risoria</i> hyb. (A 1); 4/19/01; 9/4/04; grandson; (lighter than mate).		
♀ T. <i>turtur</i> (B 1) (same as preceding); grand-dam; (darker than mate).		
♂ A 1. 4/13/03.....B 1.....dark more like <i>turtur</i> ; 1 dead 6/29/04.....		14½ mo.
♀ A 2. 4/15/03.....B 2.....light like a blond ring; dead 12/20/03.....		8 mo.
♂ B 1. 5/12.....B 3.....dark color.....alive 1904.....		12 + mo.
♂ B 2. 5/14.....B 4.....dark color.....escaped 6/1/05.....		25 + mo.
C 1. 6/12} some development in one, none in other.	D. 7/7; broken.	
C 2. 6/14}		
E 1. 7/21.....B 5.....dark; no other record.		
♀ E 2. 7/23.....B 6.....light, trace of red.....dead 5/24/06.....		34 mo.
1 "These young are ♂ <i>turtur</i> , ♀ <i>alba</i> , ♂ <i>risoria</i> ."		
		(DD 6, C).

TABLE I21.

♂ alba- <i>ris.</i> × <i>ris.-alba</i> × <i>turtur</i> hyb. (D 1); 4/20/00; darker hybrid.		
♀ St. <i>risoria</i> (7); 1900.		

♂ A 1. 4/19/01; complexion pale, as in <i>risoria</i> (see pl. 37); dead 9/4/04.		
A 2. 4/21/01; (weak, relieved); dead 5/7/01.		

B. 5/22; no development	C 1. 6. 2; no development.	D 1. 7/14; no record.
	C 2. 6/4; no development.	D 2. 7/16; no record.

♀ E 1. 8/3; complexion strongly like <i>turtur</i> ; blind eye; killed (pl. 38).		
♂ E 2. 8/5; complexion lighter, more like <i>risoria</i> ; dead 3/5/04.		

F 1. 11/3; some development.		
F 2. 11/5; some development.		

♂ G 1. 12/12; <i>risoria</i> -like; no trace of neck spots in first plumage; dead 3/26/04.		
G 2. 12/14; developed only a circle of blood.		

H 1. 1/19/02; some development.		
♂ H 2. 1/21/02; <i>risoria</i> -like (see pl. 38); dead 4/26/04.		

I 1. 3/1; developed nearly to hatching.		♀ J 1. 4/5; color pale <i>risoria</i> ; dead 11/24/02.
I 2. 3/3; developed a few days.		J 2. 4/7; no development.
K 1. 5/7; some development.	L. 6/27; nearly hatched.	M 1. 7/18; pricked shell.
K 2. 5/9; no development.		M 2. 7/20; nearly hatched.
N 1. 8/11; trace of development.		O 1. 9/30; did not hatch.
N 2. 8/13; some development.		♀ O 2. 10/2; <i>risoria</i> like; dead 1/6/03.
		(DD 3, C)

TABLE I22.

♂ trispecific (D 1); 4/20/00 (table 119); darker hybrid.		
♀ St. <i>alba</i> (O); 1902.		

♀ A 1. 4/8/03.....complexion dusky; more like <i>turtur</i> ; dead 7/14/03.....		3 mo.
A 2. 4/10/03; some development.		

♀ B 1. 5/12.....pricked shell, late; possibly deserted.		
♀ B 2. 5/14.....D 2.....color like <i>risoria</i>	dead 5/17/05.....	2 yr.

C 1. 7/10; did not hatch.		
C 2. 7/12.....D 3.....color lighter than <i>risoria</i>	dead (cold) 4/18/04.....	9 + mo.

D 1. 8/12; not tested.		
D 2. 8/14; not tested.		

♂ E 1. 10/3.....D 4.....color dark.....	? alive 1/3/05.....	1 + yr.
♀ E 2. 10/5.....D 5.....color light; lighter than <i>risoria</i>	dead 3/1/04.....	5 mo.

F 1. 1/13/04; developed only a light circle of blood.		
F 2. 1/15/04; developed only a light circle of blood.		

♀ G 1. 4/3.....D 6.....juvenile medium dark, ad. light.....	dead 9/9/05.....	1 yr. 5 mo.
♀ G 2. 4/5.....D 7.....juvenile medium dark, ad. light.....	dead 9/7/05.....	1 yr. 5 mo.

♀ H 1. 5/12.....D 8.....color light as <i>risoria</i>	dead 12/26/06.....	1 yr. 7½ mo.
H 2. 5/14; no record.		

I 1. 6/11; no record.	J 1. 7/23; no development.	
I 2. 6/13; imperfect.	♀ J 2. 7/25.....D 9.....lighter than <i>risoria</i> (see pl. 38); alive 1907.....	3 + yr.

K 1. 8/28; no test.	L 1. 12/16; juvenile like <i>risoria</i> ; died early (care).	
K 2. 8/30; no test.	L 2. 12/18.....D 10.....juvenile like <i>risoria</i>.....died at 10 days (care ?).	

M. 2/11/05; no development.		
		(DD 3, C)

TABLE 123.

σ^{α} alba-ris. \times turtur hyb. (G) ; 7/1/00; (prob. died Mar. 1910).
 ♀ St. risoria (6); (1900).

A. 5/14/01; no development.	F 1. 2/14/02; 10 day embryo.
σ^{α} B 1. 8/10; hatched; light; dead 3/9/03.	♀ F 2. 2/16/02; light (fertile).
σ^{α} B 2. 8/12; hatched; light (fertile); dead 4/3/05.	♀ G. 4/12; light; dead 9/4/04.
σ^{α} C 1. 10/23; hatched; dark, dead.	σ^{α} H. 5/14; dark; dead 10/21/05.
σ^{α} C 2. 10/25; dark (fertile); dead 2/3/04.	σ^{α} I. 6/30; dark; dead 9/6/04 (pl. 39).
D 1. 12/14; developed only blood ring.	♀ J 1. 8/11; dark; dead 8/28/03.
D 2. 12/16; developed only blood ring.	♀ J 2. 8/13; hatched.
♀ E 1. 1/8/02; dark, killed.	K. 10/1; dark; dead 2/22/03.
E 2. 1/10/02; blood ring only.	(F 18, C)

The daughter G (4/12/02) of the above mated with her father.

A 1. 5/11/03; nearly hatched.	B 1. 5/1/04
A 2. 5/13/03; developed 7 to 10 days.	B 2. 5/3/04
(Other eggs laid, substituted, during 1903).	
	C 1. 6/1; no development.
	C 2. 6/3; no development.

A third ♀, orient-risoria hyb. (7) (8/30/04), was given to this σ^{α} in 1905.

A 1. 6/6/05; developed few days.	B 1. 7/9; no development.	C 1. 8/23; probably no development.
A 2. 6/8/05; developed few days.	B 2. 7/11; no development.	C 2. 8/25; probably no development.
(DD 3, DD 16)		

σ^{α} alba-ris. \times ris.-alba \times turtur hyb. (J 1); 4/30/01; killed 2/4/05.
 ♀ St. risoria (6); (1900).

A 1. 4/18/03; hatched; dark.	C 1. no development.
♀ A 2. 4/20/03; hatched; dark, but lighter than A 1.	C 2. no development.
B 1. 5/24; developed; did not prick shell.	D 1. probably no development.
B 2. 5/26; developed a little.	D 2. probably no development.
(DD 6, C)	

TABLE 124.

σ^{α} alba-ris. \times ris.-alba \times tur. \times risoria (C 2); 10/25/01; dark.
 ♀ hum.-ris. \times risoria (E 2); 7/23/01; dark.

AA1. 4/26/02; no development. ¹	D 1. 2/24/03; no development.	H 1. 5/25; some development.
AA2. 4/28/02; no development.	D 2. 2/26/03; no development.	H 2. 5/27; some development.
A. 5/23; no record.	E 1. 3/16; no development.	I. 7/2; no record.
♀ B 1. 7/13; one failed, one ♀ reddish	♀ E 2. 3/18; hatched blond.	J 1. 7/19; no development.
♀ B 2. 7/15/ dark.	F. 4/18; not hatched.	J 2. 7/21; no development.
C 1. 8/10; little development.	G 1. 5/5; no development.	K 1. 8/6; probably no development.
C 2. 8/12; little development.	G 2. 5/7; no development.	K 2. 8/8; probably no development.
(DD 16)		

¹ Eggs AA 1 and AA 2 laid by this female while with a male of composition similar to C 2.—EDITOR.

TABLE 125.

Pair 1.

σ^{α} St. alba (O); hatched 1900.
 ♀ alba-ris. \times ris.-alba \times turtur (D 2); 4/22/00.

A. 3/29; thin shell.	C 1. 4/15; no development.	E 1. 5/13; no record.	F 1. 7/10; no development.
B 1. 4/5; lost.	C 2. 4/17; no development.	E 2. 5/13; no record.	F 2. 7/12; no development.
B 2. 4/7; thin shell.	D. 4/29; no development.		G. 7/21; no record.

Pair 2.

This ♀ the following year with a σ^{α} risoria.

A 1. 4/7/02	B 1. 7/31	C 1. 8/23; no record (? no development)
one broken; other no record.	one fully developed embryo; other probably no development.	C 2. 8/25; no record (? no development)

The above female (D ♀) was further mated to a bird (B ♂) who was her half-brother, nephew, etc., (see table 120).—EDITOR.

TABLE 125 (*continued.*)*Pair 3.*

σ^3 alba-ris. \times ris.-alba \times tur. $\times \times$ ris. $\times \times \times$ turtur (B 4); 5/13/03; (inbred)¹ half-brother ++.
 φ alba-ris. \times ris.-alba \times turtur (D 2); 4/22/00; half-sister ++.

A 1. 4/12/04; little or no development.	C 1. 7/22; no development.	E 1. 3/27/05; no development.
A 2. 4/14/04; little or no development.	C 2. 7/24; no development.	E 2. 3/29/05; no development.
B 1. 5/23; no development.	D 1. 8/7; no record.	F 1. 4/29; no record.
B 2. 5/25; no development.	D 2. 8/9; no record.	F 2. probably not laid. (DD 3)

Pair 4.

σ^3 T. turtur \times T. orientalis hyb. (T0 5); 6/6/04; alive 6/15/15; 11 + yr.
 φ alba \times risoria (580); 4/29/14; alive 6/15/15; 1 + yr.

B 1. 5/11/15; hatched; dark; alive 6/16/15.	C 1. 5/29; hatched; dark; alive 6/16/15.
♀ B 2. 5/13/15; hatched; dark; accident 6/16/15.	C 2. 5/31; hatched; dark; alive 6/16/15.

¹ Escaped 6/1/05.

SEX-RATIO IN CROSSES OF FAMILIES, SUBFAMILIES, AND GENERA.

A summary of the data on the sex-ratio in the three groups of crosses considered in this chapter is given in table 126. It will be seen that first crosses which involve members of different *families* or of different *subfamilies* yield only (?) males. In both of these groups, particularly where one parent is hybrid, an occasional offspring without sex-glands is produced. When individuals belonging merely to different genera—in this case rather closely related genera—are crossed, both male and female young are produced.

There is reason to believe that different species vary in their tendency to produce male and female offspring; and that *St. alba*, for example, is one that can more readily than many others be made to yield a predominance of female offspring. But this form, along with others, has been shown to *change* in this capacity with respect to width of cross, season, overwork, etc. Regardless of what the differences among the various species in initial tendency to produce a given sex may mean, the data of this volume point out at least several of the conditions which act in such a way as most materially to *modify* the actual production of sex.

TABLE 126.—*Sex-ratio in family, subfamily, and generic crosses.*

Family.			Subfamily.			Genus.					
Species.	σ^3	φ	No gonad.	Species.	σ^3	φ	No gonad.	Species.	σ^3	φ	No gonad.
σ^3 admista	6	0	..	σ^3 carolinensis	16	0	1	σ^3 alba-ris. \times ris.-alba	3	3	..
φ risoria				φ risoria				φ turtur			
σ^3 illyrica	1	0	..	σ^3 carolinensis	2	0	..	σ^3 complex hybrid	3	2	..
φ risoria				φ alba-ris. \times ris.-alba				φ turtur			
σ^3 gyrans	7	0	..	σ^3 Zen. \times Z'dura	3	0	1 ¹	σ^3 trispecific	10	9	..
φ risoria				φ risoria				φ risoria			
σ^3 laticauda	1	0	..	σ^3 Zen. \times Z'dura	1	0	2	σ^3 trispecific hyb.	1	8	..
φ risoria				φ alba				φ alba			
σ^3 orientalis \times risoria	1	0	1					σ^3 complex hybrid	0	2	..
φ tabellaria								φ complex hybrid			
σ^3 gyrans	11	0	..								
φ risoria-alba											
σ^3 tabellaria ²	2	0	..								
φ risoria											
Total	29	0	1	Total	22	0	4	Total	17	24	..

¹ Very minute testes.

² The female common pigeon (*C. tabellaria* ♀) of unknown origin (tables 116, 117) which, with a *hybrid* male, hatched 17 young (1 σ^3 , 3 ♂♂, 3 ♀♀), is not included in this tabulation.

³ Eight of these were from a mating that gave 1 σ^3 to 8 ♀.

CHAPTER XII.

SEX-LIMITED HEREDITY IN CROSSES INVOLVING BLOND AND WHITE RING-DOVES AND RELATED SPECIES.

As early as 1896 it was found that crosses of blond and white ring-doves involve a sex-limited inheritance of white color and an approach to a similar limitation upon the inheritance of blond color. Soon afterward the reciprocal hybrids from this cross were bred, and male hybrids were back-crossed with both pure white and pure blond. Still later, crosses between whites, or blonds, or their hybrids, with two other species (*St. douraca* and *St. humilis*) of the same genus were found to show a similar association of sex and color. The results of these three series of crosses, together with matings of some of these forms with a fifth species (*Spil. suratensis*), are presented here.

A full tabulation of the data will be given in the usual manner, since it is desirable to furnish an adequate picture of the generally high degree of fertility existing between these closely related species. There are, too, features of the relation of season to fertility and to color, and data upon "overwork" and the order of eggs in the clutch, which can be presented in no other way.¹ The discussion of the data for some of the crosses has been supplied by the editor. The first group of crosses—of blond and white ring-doves—are described by the author. This description was used in the presentation of the subject to a small group of zoologists in 1897.

CROSSES OF BLOND AND WHITE RING-DOVES.

The bird which is the subject of these remarks² belongs to the family Peristeridae and to the genus *Turtur*. *Turtur risoria* is the name usually applied to it. The genus and species are described by Salvadori (Birds of the British Museum, vol. 21, 1893, p. 415), and in a footnote to the key to the species I find this remark: "It is uncertain to which species the tame dove belongs."

There is a brown variety—it is technically called an isabelline color—and also a white variety or species. One dealer speaks of this latter species as the "white Vienna dove," but on what authority I do not know. I find that authorities disagree on the question whether the white ring-dove belongs to the same species as the isabelline or blond ring.³

¹ It is not intended to schematize these results according to the current Mendelian practice, for the following reasons: (1) The breeding was not all carried out along Mendelian lines. (2) Whitman early convinced himself—before the rediscovery of Mendel's law—that even in these cases the apparent segregation of "white" and "dark" is in reality quite incomplete; the derived whites bear some pigment and are, in a measure, intermediates; the derived blonds are quite plainly intermediate in the *alba* \times *risoria* cross (though *some apparently are not so* in the reciprocal cross). (3) Again, the conclusion drawn by Dr. Whitman from the great extent and variety of his breeding work is that "dominance" and "recessiveness" are matters of degree, and that by appropriate means these may be reversed; this reversal being seen in such characters as fertility, color, and sex. Of course, we already have the Mendelian ratios as facts, and there is no doubt concerning their existence and common exhibition. But the present work is concerned chiefly with "facts about the facts," and bears upon the *interpretation* of the basis of heredity. The facts of Mendelism have encouraged an assumption of the existence of *qualitative* differences as the basis of contrasting characters; some "facts about the facts" led the author to conclude that such differences are really *quantitative* in nature, and that not gaps, but bridges, lie between contrasting characters.—EDITOR.

² Part of a stenographic report of a lecture delivered before the Zoological Club of the University of Chicago, October 13, 1897. (The copy had been somewhat revised and corrected by the author; references to the birds which were demonstrated during the lecture have been adapted for this work by the editor.)

³ Later Professor Whitman recognized these as distinct species, and treated them as *Streptopelia*, which he considered (partly after Salvadori) as of generic rank. See Chapter XV.—EDITOR.

There are certainly very clear differences between them. For example, in the young bird of the darker species there is a rich supply of "down," the bird being well covered with it. This down has a characteristic appearance, being here rather coarser and shorter than in the domestic pigeon. In the young of the white bird there is scarcely any down; at first sight they seem almost perfectly naked, and are in this respect very distinct from blond rings and from all other related species. The eggs of the white variety are on the average a little smaller, and the species itself is a little smaller than the blond ring. The white variety weighs a little less, and is a little more delicate in all its characters. It is certainly not as strong a species as the dark or blond ring, but the general behavior of the two forms agrees very closely; there is a mark on the neck of the white bird which also reveals a close affinity. At first sight the white bird seems to lack the very prominent black collar of the blond birds, but on closer examination the feathers of the region of the collar are found to have a slightly yellowish tinge. There is no doubt about its having the mark or imprint of the "ring" or collar.

I began my experiments in crossing by making the reciprocal crosses. In one case a white male was mated with a brown female; in the other, a brown male was used with a white female. From this last cross I obtained during the first summer some 15 birds, all of which were of the dark color. There was, however, a difference in depth of color among these offspring. Some were light brown, while others were dark, darker even than the dark parent. In the first cross, where a white male with a brown female were used, something less than half the birds were white; the rest of them were light isabelline.

The results of the second year's work with these first-generation hybrids were as follows: Three pairs were mated. The males were all of the light color (one shown in pl. 25), all having been derived from a pair in which the male was white and the female brown (σ *alba* \times ♀ *risoria*). The females were from the other family, where the father was brown (♀ *risoria* \times ♂ *alba*), and most of these females were of the darker color. One pair I gave to Dr. Watase, who kept an account of the results. He obtained 10 young during the summer. In one case, I believe, an egg was broken before the young hatched, and he was unable to tell what the color would be. Of the others which he succeeded in raising, 5 were white and 5 of the darker color.

From my own summer's work with 3 pairs of parents I have only 1 dark and 1 white bird alive; 2 have died. I have found these species very convenient ones for experimentation, but during the present summer these birds have been used chiefly for taking care of the young of other birds; this has prevented my getting more of their own young from them. The point of chief interest in these results is this: *In all these pairs, every one of the parents being brown, we get quite a large proportion of white young birds. In other words, the white color of the parent bird shows not in the second, but in the third generation.*⁴ (A 1/1)

The results⁵ of the *alba* \times *risoria* cross are given in table 127. There were 5 young which resembled *risoria* and are called "light brown"; 4 young are designated "white." The few white birds whose sex was known were females; the 3 "light brown" birds of known sex were males. The reciprocal cross gave birds of at least two shades of "brown." The darker of these were females (like sire), but 1 female was not of this color; 2 males and a female were of the lighter color (table 128).

Males from the *alba*-*risoria* cross were mated to females of the *risoria*-*alba* cross with the result as summarized in table 129 and more fully given in tables

⁴ That is, in the F_2 generation. It is interesting that this feature of Mendelism was noted by Whitman as early as 1897. This had, however, been noted earlier, on a few forms, not only by Mendel, but by Naudin and by Darwin.—EDITOR.

⁵ The statements and summaries from this point, except those marked as quotations, are made by the editor; the data, of course, are those of the author.

130 and 131. It will be seen that brown and white offspring appear in a nearly 3 : 1 ratio (49 to 18) and that all of the white young of known sex (7) were females. Some of the brown birds of known sex (5 to 19) were also females. That the "brown" birds were by no means the equivalent of pure *St. risoria* will be made clear by a reference to pl. 25.

TABLE 127.

	σ^3 St. alba (W); probably alive 1900.	
	♀ St. risoria (D 1); 7/15/95.	
B 1. 3/29/96; unhatched.	D 1. 5/29; disturbed.	♀ G. 9/27; white.
B 2. 3/31/96; unhatched.	D 2. 5/31; light brown.	♀ H 1. 11/3; white.
B. 4/21; no test.	E 1. 6/28; white.	♂ H 2. 11/5; light brown.
C. 4/30; white.	♂ E 2. 6/30; light brown.	I. 12/1; no test.
	♂ F 1. 7/31; light brown.	
	F 2. 8/2; light brown.	
		(C 7/10)

TABLE 128.

♀ A 1. 4/9/96; dark brown; 172 g.	σ^3 St. risoria (\times); (155 grams wt.).	E 1. 9/4; unhatched.
σ^3 A 2. 4/11/96; light brown; 167 g.	♀ St. alba (W 2); (151 g. wt.).	E 2. 9/6; dark.
♀ B 1. 5/14; dark brown; 177 g.		F 1. 11/26; deserted.
σ^3 B 2. 5/16; light brown; 154 g.		F 2. 11/28; deserted.
♀ C 1. 6/21; dark brown; 157 g.		G 1. 1/4/96; killed by cold.
♀ C 2. 6/23; dark brown; 153 g.		G 2. 1/6/96; killed by cold.
♀ D 1. 7/29; dark brown; 142 g.		
♀ D 2. 7/31; light brown; 176 g.		
		(X 5)

TABLE 129.—Color and sex of offspring of *alba-risoria* hybrid males \times *risoria-alba* hybrid females.

	No.	Males.	Females.	Doubtful
Pair I (brown... (white...)	13	4	1	8
	5	...	1	4
Pair II (brown... (white...)	16	4	3	9
	7	...	3	4
Pair III (brown... (white...)	20	6	1	13
	6	...	3	3
Total. (brown... (white...)	49	14	5	30
	18	0	7	11

TABLE 130.

Pair 1.

σ^3 alba \times risoria (WDLF 2); light brown; 8/16/96; 6/28/99.
♀ risoria \times alba (XW 2 D 1); dark brown; 8/13/96.

A 1. 5/9/97; not hatched.	F 1. 1/8/98; no development.	K 1. 8/20; brown.
A 2. 5/11/97; record indefinite.	F 2. 1/10/98; brown.	K 2. 8/22; brown.
σ^3 B 1. 6/11; light brown.	G 1. 2/9; brown. ¹	L 1. 10/5; white.
♀ B 2. 6/13; light brown.	G 2. 2/11; white.	L 2. 10/7; white.
σ^3 C 1. 7/20; brown.	H 1. 4/24; removed.	M 1. 10/27; hatched.
σ^3 C 2. 7/22; brown.	H 2. 4/26.	M 2. 10/29; hatched.
♀ D 1. 8/25; white.	I 1. 6/7; brown.	N. 4/9/99; no record.
σ^3 D 2. 8/27; brown.	I 2. 6/9; brown.	O 1. 4/20; no test.
E 1. 11/24; hatched.	J 1. 7/13; brown.	O 2. 4/22; no test.
E 2. 11/26; hatched.	J 2. 7/15; not hatched.	P 1. 5/27; white. ¹
		P 2. 5/29; brown. (C 7/13. P 16)

¹ Shades of brown were apparently not distinguished during this year.—EDITOR.

TABLE 130 (*continued*).

Pair 2.

 σ^a alba \times risoria (WD 1 F 1); light brown; 8/15/96. φ risoria \times alba (XW 2 C 2); dark brown; 7/7/96.

A 1. 4/20/97; removed.	H 1. 1/8/98; brown. ¹	O 1. 8/27/98; removed.
A 2. 4/22/97; removed.	H 2. 1/10/98; brown.	O 2. 8/29/98; removed.
B 1. 5. 15; light brown.	I 1. 3. 17; brown (?).	P 1. 10/8 ?; brown.
♀ B 2. 5. 17; white.	I 2. 3. 19; brown (?).	P 2. 10/10; white.
♀ C 1. 6. 17; white.	J 1. 4/9; brown.	Q. 11/12; no test.
C 2. 6. 19; brown.	J 2. 4/11; no record.	σ^a R 1. 12/2; brown.
♀ D 1. 7. 22; brown.	K 1. 5. 17/98; white.	♀ R 2. 12/4; white.
σ^a D 2. 7. 24; brown.	K 2. 5. 19/98; brown.	S 1. 3/25/99; removed.
♀ E 1. 8. 22; brown.	L 1. 6/16; no test.	S 2. 3/27/99; removed.
σ^a E 2. 8. 24; brown.	L 2. 6. 18; no test.	T 1. 4/15; no record.
♂ F 1. 10/14; light brown.	M 1. 6/26; white.	T 2. 4/17; no record.
♀ F 2. 10/16 ?; light brown.	M 2. 6/28; white.	
G 1. 11/29; no record.	N 1. 8/12; broken.	
G 2. 12/1; no record.	N 2. 8/14; broken.	

(C 7/9, C 7/10)

¹ Shades of brown were apparently not distinguished during this year.—EDITOR.

TABLE 131.

Pair 3.

 σ^a alba \times risoria (WD 1 E 2); light brown; 7/14/96; 8/9/99. φ risoria \times alba (XW 2 C 1); dark brown; 7/6/96.

♀ A 1. 4/30/97; white.	H 1. 4/2/98; brown.	O 1. 3/15/99; no test.
A 2. 5/2; light brown.	H 2. 4/4/98; white.	O 2. 3/17/99; no test.
♂ B 1. 6/8; light brown.	I 1. 6/8; brown.	P 1. 4/9; no test.
B 2. 6/10; no record.	I 2. 6/10; brown.	P 2. 4/11; no test.
♀ C 1. 7/15; light brown.	J 1. 7/6; brown.	Q 1. 5/2; no test.
σ^a C 2. 7. 17; light brown.	J 2. 7/8; brown.	Q 2. 5/4; no test.
D. 8/19; unhatched; no second.	K 1. 8/8; brown.	R 1. 5/14; no record.
	K 2. 8/10; broken.	R 2. 5/16; no record.
♀ E 1. 9/19; white.	L 1. 10/6; no test.	S 1. 5/31; white.
σ^a E 2. 9. 21; brown (pl. 25).	L 2. 10/8; no test.	σ^a S 2. 6/2; brown.
♂ F 1. 11/2; light brown.	M 1. 11/6; brown.	T 1. 7/2; brown.
σ^a F 2. 11/4; light brown.	M 2. 11/8; brown.	T 2. 7/4; brown.
G 1. 2/17/98; white.	N 1. 12/3; brown.	U 1. 7/29; no record.
G 2. 2/19/98; brown.	♀ N 2. 12/5; white.	U 2. 7/31; no record.

(C 7/8)

TABLE 132.

 σ^a alba-ris. \times ris.-alba hyb. (B 1); 6/8/97; light brown. φ St. alba (W); white.

A 1. 7/28/98; no development.	♀ F 1. 5/1/99; brown.	K 1 and K 2, not tested.
A 2. 7/30/98; no development.	F 2. 5/3/99; white.	L 1. 11/1; brown.
B 1. 8/20; brown.	δ G 1. 6/5; white.	L 2. 11/3; white.
B 2. 8/22; white.	σ^a G 2. 6/7; white.	M 1. 3/24/00; white.
C 1 and C 2, not tested.	H 1 and H 2, not tested.	M 2. 3/26/00; failed or white.
D 1. 11/3; one hatched.	I 1. 8/4; white.	N 1 and N 2, not tested.
D 2. 11/5; record uncertain.	I 2. 8/6; white.	O 1. 5/25; failed.
E 1 and E 2, not tested.	J 1. 8/31; deserted.	O 2. 5/27; white.
	J 2. 9/2; deserted.	

(X 5, P 16)

TABLE 133.

 σ^a alba-ris. \times ris.-alba hyb. (C 1); 6/20/97; alive 7/25/04; brown. φ St. risoria (G); 10/23/95; alive 7/25/04; brown.

C 1. 11/16/99; brown.	L 1. 8/29/00; brown. ¹	T 1. 6/23/04; white.
C 2. 11/18/99; brown.	L 2. 8/31/00; brown.	T 2. 6/25/04; pale blond.
H 1. 4/26/00; soft shell.	N 1. 3/6/00; white.	
H 2. 4/28/00; white.	N 2. 3/8/00; white.	

(X 7)

¹ It is practically certain that these were brown birds, though the color is not recorded at this point.—EDITOR.

Two of the F_2 hybrid males (of light brown color) were back-crossed with pure *St. alba* (table 132) and with *St. risoria* (table 133). Both white and brown young arose from both of these matings. With *alba* there were 9 white to 3 brown;⁶ with *risoria*, 4 white to 5 brown. The sex from none of the birds from the F_2 hybrid \times *risoria* mating is known; but from the F_2 hybrid \times *alba* mating the only brown bird of known sex was a female, and the 2 known males were of white color.⁷

BLOND RINGS AND BLOND-WHITE HYBRIDS CROSSED WITH JAPANESE RINGS.

The Japanese ring-dove (*St. douraca*) is in most respects not greatly unlike the blond ring (*St. risoria*), but it is darker in color and the complexion of the newly hatched young is decidedly darker. When the female *douraca* is mated to a male *risoria* (table 134) the offspring present two colors; one is nearly as light as *risoria* and the other nearly as dark as *douraca*. The lighter colored (like sire) birds are apparently all females and the darker forms (like dam) all males.

The reciprocal cross gave again birds of two colors and apparently all of the resulting females are of the darker color (like sire). The males, however, may be of light or of dark color. The number of young obtained from this cross was too few to throw much light upon the sex-ratio, or upon the proportions of the various colors.

A *risoria* \times *douraca* hybrid male mated to a blond ring gave (table 135) about 7 light and 5 dark offspring; 2 known males were dark and 1 was light; 3 of the females were light and 1 was dark. Two of the young of this cross—Nos. *F 1* and *F 2*—were mated and found to be fully fertile; they hatched 2 dark and 1 light colored young. One of these had a malformation of the upper mandible—beak—which in these studies has been very frequently found among birds from *weak* germs, germs of hybrid origin, and from inbreds.

The cross of a *risoria-alba* hybrid with a *douraca* female yielded young which approximate to the colors of the three parent species (table 136, pair 1). But it is interesting to find here that 3 of the 6 young are "white," though white is "recessive" (it is sex-limited) with both *risoria* and *douraca*, and though the offspring here are but one-fourth *alba*.⁸ These 3 white young were all females, as was also a *risoria*-colored member of this fraternity; the two young which were nearly as dark as the mother were males.

The mating *inter se* of 2 pairs of these *risoria-alba* \times *douraca* hybrids is of interest in showing the lack of equivalence of the germs produced by the 2 pairs of brothers and sisters from the same fraternity. Pair I (table 137) produced 3 dark and 4 white⁹ young, besides 5 eggs incapable of complete development. Pair II threw no white birds in their total of 10 young. Here, however, 6 young were of the lighter shade of *risoria*, and 4 were nearly as dark as *douraca*. The "develop-

⁶ It is notable that the "brown" birds here arose in each instance from the first egg of the clutch, and that the second egg in each of these same three cases developed into a "white" bird.

⁷ The further breeding of the white and blond rings was later turned over to Dr. R. M. Strong, who has already reported his results (Biol. Bull., vol. 23, 1912, p. 293).

⁸ It is quite probable that the predominance of white offspring here is in part related to the fact that the sire (*B 1*) had *alba* as his mother. Both sire and dam, however, died of tuberculosis soon after these eggs were produced, and probably conditions (weakness) favored the production of females (4 ♀ to 2 ♂). From another strong pair (3) here were produced 3 males to 2 females. These numbers, of course, are quite small; they are given for the sake of completeness.—EDITOR.

⁹ Here again the "recessive white" appears in half (4 of 7) of the offspring, although these young are only one-fourth *St. alba*.—EDITOR.

mental strength" of these germs is here obviously higher than in those from pair I. In this second pair we get failure to complete the development in only the first clutch, and two "very light colored" birds (no whites) only from the last clutch of the season. It will be noted that pair I produced one more clutch of eggs than did II. From pair I—the "weaker" series—were produced 2 males and 3 females, the sexes being of both colors. From pair II—the "stronger" series—2 males and 2 females are known; the light-colored young are of both sexes. The sex of all the dark birds is unknown.

Besides the association of sex and color in inheritance already noted in this cross, or group of crosses, it may be further remarked that the tables indicate a high degree of fertility, and coincidentally a fairly long term of life of the offspring. Inbreeding (table 137) probably introduced a reduction of both fertility and longevity.

TABLE 134.

Pair 1.

$\textcircled{\text{f}}$ A 1. 7/19/01	light, nearly color of <i>risoria</i> .	dead 3/11/05	44 mo.
$\textcircled{\text{f}}$ A 2. 7/21/01	decidedly dark (<i>douracea</i>)	dead 1/13/04	30 mo.
$\textcircled{\text{f}}$ B 1. 4/6/02	complexion dark; ad. color pale brownish.	9/6/04	29 mo.
B 2. 4/8/02	complexion light; ad. color pale brownish.		
$\textcircled{\text{f}}$ C 1. 5/12	light, color of <i>risoria</i> ; fertile.		
$\textcircled{\text{f}}$ C 2. 5/14	dark like <i>douracea</i> ; fertile.		
$\textcircled{\text{f}}$ D 1. 6/29	complexion dark	alive 4/9/03; fertile.	10+ mo.
$\textcircled{\text{f}}$ D 2. 7/1	complexion dark	dead 9/22/02 (trip)	2+ mo.

Pair 2. $\textcircled{\text{f}}$ St. *douracea*; alive 8/3/03. $\textcircled{\text{f}}$ St. *risoria* (C); alive 8/3/03.

$\textcircled{\text{f}}$ A 1. 4/10/02	dark, like reciprocal dark birds	dead 11/5/02	7 mo.
$\textcircled{\text{f}}$ A 2. 4/12/02	dark	dead 11/28/02	7½ mo.
$\textcircled{\text{f}}$ B 1. 5/13	quite dark	dead 4/10/04	23 mo.
B 2. 5/15	quite dark		
$\textcircled{\text{f}}$ C 1. 6/24	dark color	dead 12/28/04	30 mo.
C 2. 6/26	complexion dark		
D. 8/1	color ?	probably died early.	
$\textcircled{\text{f}}$ E 1. 10/1	nearly as light as <i>risoria</i>	dead 1/24/04	16 mo.
E 2. 10/3	nearly as light as <i>risoria</i>	dead very young	?1 mo.

(P 13, A 11)

TABLE 135.

 $\textcircled{\text{f}}$ *risoria-douracea* (A 2); very dark; 7/21/01; 1/13/04; 2 yr. 6 mo. $\textcircled{\text{f}}$ St. *risoria* (from 1901); isabelline; alive 1903; 2+ yr.

$\textcircled{\text{f}}$ A 1. 4/21/02	hatched, complexion dark; ad. like <i>risoria</i>	dead 10/20/04	2 yr. 6 mo.
$\textcircled{\text{f}}$ A 2. 4/23/02	hatched, complexion not as dark as A 1 (fertile) ?		
B 1. 5/5	hatched, color light.		
B 2. 5/7	hatched, complexion light	dead 7/5/02	2 mo.
C 1. 7/26; broken.			
C 2. 7/28; hatched, color like <i>risoria</i> (fertile).		D. 10/17; no record.	
$\textcircled{\text{f}}$ E 1. 12/1	one, $\textcircled{\text{f}}$ dark; other, ♀ light	(dead 4/22/05	2 yr. 5 mo.
$\textcircled{\text{f}}$ E 2. 12/3	one, $\textcircled{\text{f}}$ dark; other, ♀ light	dead 5/22/03	6 mo.
$\textcircled{\text{f}}$ F 1. 2/22/03	hatched, light	dead 9/9/08	5 yr. 7 mo.
$\textcircled{\text{f}}$ F 2. 2/24/03	hatched, dark	dead 7/5/05	2 yr. 5 mo.
$\textcircled{\text{f}}$ G 1. 7/20	one, ♀ light (fertile); other, dark	(dead 10/19/04	1 yr. 3 mo.
$\textcircled{\text{f}}$ G 2. 7/22		dead early (?)	?1 mo.
H 1. 9/12; broken.			
H 2. 9/14	hatched, complexion dark	dead 11/14/04	1 yr. 2 mo.

(P 13, A 11)



A. Adult male Chinese red ring-dove, *Streptopelia humilis*. One year old. ♂ 0.7. Hayashi del., May 1901.
B. Juvenile male Chinese red ring, *Streptopelia humilis*. Age 6 to 7 weeks. ♂ 0.7. Hayashi del., July 1901.



A. Juvenal female, *St. humilis* (Th) \times *St. risoria* (h). Hybrid (M1). Age 7 weeks. $\times 0.7$. Hayashi del., July 1901.
B. Adult male, *St. humilis* (Th) \times *St. risoria* (h). Hybrid (C2). Hatched July 1, 1900. $\times 0.6$. Hayashi del.
This bird was mated to his sister and is the sire of the second generation hybrid (D1) shown in adult plumage in plate 23, figure A, and in juvenal plumage in plate 23, figure B. Note that the color is intermediate; the upper and lower margins of the neck-mark show traces of the white present in *St. risoria*.

TABLE 136.

Pair 1.

δ^1 Risoria-alba hyb. (B 1); 3/14/08; 1/30/10 (tuberculosis); very light blond color.
 φ St. douraca (imported) 1908; 5/17/10 (tuberculosis); darker color.

AA 1. 5/27/09. RD 1. dark.
 AA 2. 5/29/09. RD 2. dark (these eggs laid while mated to a pure risoria).

δ^1 A 1. 6/27/09.	RD 3.	dark (trace lighter than dam)	. . . . .	dead 11/17/12. . . . .	. . . . .	41 mo.
φ A 2. 6/29/09.	RD 4.	white	. . . . .	11/10/10. . . . .	. . . . .	16½ mo.
φ B 1. 8/10.	RD 5.	light risoria	. . . . .	dead 10/24/10. . . . .	. . . . .	14 mo.
φ B 2. 8/12.	RD 6.	white (fertile)	. . . . .	stolen 7/19/12. . . . .	. . . . .	35+ mo.
δ^1 and φ C 1. 10/8 ¹ C 2 (?)	RD 7.	δ^1 dark (fertile)	. . . . .	dead 4/20/12. . . . .	. . . . .	30½ mo.
C 2. 10/10 ¹ C 1 (?)	RD 8.	φ white	. . . . .	dead 9/3/12. . . . .	. . . . .	35½ mo.

(P 10, P 12)

Pair 2.

A δ^1 St. risoria¹ (S2) (imp. 1908) was given 2/18/10; alive 7/5/11; blond color.
 A 1. 2/27/10; shell weak, broken.
 A 2. 3/1/10; shell weak, broken.

B 1. 4/6; failed to hatch.

 φ B 2. 4/8; RD 9; light blond; 7/24/13.

Pair 3.

Another φ St. douraea given May, 1910 (untag.; when or whether dead not known).

φ A 1. 6/1/10.	RD 10.	light blond	. . . . .	dead 6/4/11. . . . .	. . . . .	12 mo.
φ A 2. 6/3/10.	RD 11.	light blond	. . . . .	dead 5/24/12. . . . .	. . . . .	24 mo.
B 1. 7/17.	RD 12.	light grayish blond	. . . . .	dead or disappeared before 2/5/11.	. . . . .
δ^1 B 2. 7/19.	RD 13.	light grayish blond	. . . . .	killed 10/23/13. . . . .	. . . . .	39+ mo.
δ^1 C 1. 8/26.	RD 14.	light grayish blond	. . . . .	killed 10/23/13. . . . .	. . . . .	38+ mo.
δ^1 C 2. 8/28.	RD 15.	light grayish blond	. . . . .	dead 9/18/14. . . . .	. . . . .	49 mo.

(P 12, XX 11)

¹ This bird was probably contaminated with *St. alba*, though imported as pure blond.—EDITOR.

TABLE 137.—Results of mating *risoria-alba* \times *douraca* hybrids inter se.

Pair 1.

 δ^1 Risoria-alba \times douraca hyb. (3); 11/17/12; brother; dark. φ Risoria-alba \times douraca hyb. (8); 9/3/12; sister; white.

A 1. 3/10/10; white; full term embryo. ¹	δ^1 D 1. 7/23.	RD 3-D.	dark	δ^1 D 5/26/13 δ^1 .
A 2. 3/12/10; white; full term embryo.	δ^1 D 2. 7/25.	RD 3-D.	dark	δ^1 D 3/25/13 φ .
B 1. 5/20; some development.	δ^1 E 1. 9/19.	RD 3-E.	white	dead 2/17/11.
B 2. 5/22; some development.	E 2. 9/21.	no development.		
C 1. 6/10; some development.	φ F 1. 10/9.	dark	dead 11/26/13.	
C 2. 6/12; some development.	φ F 2. 10/11.	white	dead 11/16/11.	

Pair 2.

 δ^1 Risoria-alba \times douraca hyb. (7); 10/9/09; 1/20/12; brother; very dark. φ Risoria-alba \times douraca hyb. (6); 8/12/09; 7/19/12; sister; white.

A 1. 3/7/10; developed, failed to prick shell; complexion light.	δ^1 E 1. 9/19.	RD 3-E.	white	dead 2/17/11.
A 2. 3/9/10; developed, pricked shell, failed; complexion dark.	E 2. 9/21.	no development.		
B 1. 5/12.	RD 7-B.	dark, disappeared before 11/4/13.		
Q B 2. 5/14.	RD 7-B.	lighter	10. 28. 11.	17½ mo.
δ^1 C 1. 7/5.	RD 7-C.	dark	one dead 8/7/11.	13 mo.
δ^1 C 2. 7/7.	RD 7-C.	lighter	one before 11/4/13.	2 mo.
δ^1 D 1. 8/20.	RD 7-D.	lighter	3. 15. 13.	31 mo.
D 2. 8/22.	RD 7-D.	dark	probably died early.	
E 1. 10/10.	RD 7-E.	light risoria	11/8/10 (cold).	
E 2. 10/12.	RD 7-E.	light risoria	11/7/10 (cold).	(F)

¹ This clutch was deserted.

BLOND AND WHITE RINGS CROSSED WITH RED RINGS.

The red ring-dove (*St. humilis*) is a much darker bird than the blond ring. It has a pronounced vinous-reddish cast, and the unfeathered young have a decidedly dark complexion. An adult male and a juvenal male are figured in pl. 21. In

crosses with white and blond rings, the male of these species and a female red ring being used, the male offspring all have the color of the mother; the female offspring all have the color (lighter) of the sire.

A white ring male mated to a red ring (table 138) gave 18 white and 18 dark young. The 18 white birds are all known to have been females. The sex of 11 dark birds is known; all were males. Three matings of *alba-humilis* hybrids indicate (table 148) a very low fertility for these birds. From a mating of one of these females with a *risoria* × *humilis* male, two dark young (spring) and one light *risoria* (summer), but no whites, were produced.

Crosses of blond rings with red rings gave results similar to those obtained from white rings with red rings. A blond ring male mated to the red ring female threw young of two colors—7 dark, 4 blond. The sex of 4 of the dark birds is known; they were all males; the 3 blond birds of known sex were females (table 139).

The reciprocal of this cross also yielded young of two colors, though these colors were apparently by no means as distinct as in the opposite cross. The color records are adequate for the present purpose in very few cases (table 140), and a conclusion can hardly be drawn from them. An adult male of this composition is shown in pl. 22; a female in juvenal plumage also in pl. 22.

The sex was ascertained in 23 young of the *humilis-risoria* cross; there were 11 males and 12 females. But the sexes were not evenly distributed throughout the three yearly periods. Instead, 4 males and 3 females were from 1900, which is the year of longest average life for offspring. In 1901 again 4 males and 3 females were recorded, while from the third year, that of the shortest-lived offspring, 3 males and 6 females were recorded.

TABLE 138.

♂ St. alba (O); 1901 ?; 10/10/06; 5 (?) yr.
♀ St. humilis (2 r); 8/30/01; 4/?/06.

♂ A 1. 5/30/02.....dark.....1 15/05.....	31½ mo.	N 1. 5/10; no record.
♂ A 2. 6/1/02.....dark.....alive 1/31/05.....	32 mo.	♂ N 2. 5/12.....dark.....8/9/05.....15 mo.
B 1. 6/29; 14 day embryo.		♂ O 1. 6/24.....dark.....8/20/05.....14 mo.
♀ B 2. 7/1.....white.....alive 1/31/05.....	31 mo.	♀ O 2. 6/26; white.
♀ C 1. 7/29.....white.....5/1/05.....	33 mo	P 1. 7/12; dark.
♂ C 2. 7/31.....dark.....8/2/05.....	36 mo.	♀ P 2. 7/14.....white.....6/22/06.....23 mo.
♀ D 1. 8/28.....white.....aut. 1902.....	3 mo.	♂ Q 1. 8/14.....dark.....2/20/05.....6½ mo.
D 2. no record.		♂ Q 2. 8/16.....dark.....4/10/05.....8 mo.
♂ E 1. 9/29.....dark.....2/10/04.....	16½ mo.	♀ R 1. 9/16; white.
♀ E 2. 10/1.....white.....10/15/05.....	36½ mo.	R 2. 9/18; dark.
F 1. 3/22/03; no development.		S. 3 21/05; dark; crooked neck (killed).
F 2. 3/24/03; deserted.		T 1. 4/19; no test.
♀ G 1. 4/12; white; failed to hatch.		T 2. 4/21; no test.
G 2. 4/14; dark.		U 1. 5/10; no test.
H 1. 5/14; unhatched.		U 2. 5/12; no test.
♀ H 2. 5/16; white; lived 1 day (lice).		V 1. 6/14 ¹ one dark (lice-killed).
♀ I 1. 6/3.....white.....12/3/06.....	39 mo.	V 2. 6/16 ¹
♀ I 2. 6/5.....white.....5/8/05.....	23 mo.	W 1. 7/4 ¹ one dark.
♀ J 1. 7/6; white; lived 1 day.		W 2. 7/6 ¹
♀ J 2. 7/8; white.		♀ X 1. 8/2.....white.....(lice-killed).
K 1. 8/10; no record.		♀ X 2. 8/4.....white.....1/1/06.....5 mo.
K 2. 8/12; no record.		♂ Y 1. 8/23.....dark.....5/?/06.....9 mo.
♀ L 1. 9/13; white.		♀ Y 2. 8/25; white.
♀ L 2. 9/15; white.		♂ Z 1. 10/2.....dark.....12/25/06.....14 mo.
M 1. 4/9/04; dark.		♂ Z 2. 10/4; dark
M 2. 4/11/04; no development.		(DD 8, A 12)

The hybrids obtained from the blond and red ring crosses were further bred as follows:

A *humilis-risoria* male and another *risoria-humilis* male were mated to female *alba*. The former cross tested fully fertile (table 141); four tests failed with the latter. In all tests elsewhere made (tables 148, 149) these *risoria-humilis* hybrids, like the *alba-humilis* hybrids referred to above, show a very low fertility; or rather they show many germs which fall short of complete development.

The *humilis-risoria* hybrids, particularly the males of the group, seem very much more fertile. This fertility is quite complete with female *alba* (table 141); it is practically the same with female *humilis* (table 142); it is much less so with female *risoria* (table 143) and with female *humilis-risoria* fertility is very low (tables 146, 147). The female *humilis-risoria* were but partially fertile with a

TABLE 139.

Pair 1.

σ^a St. <i>risoria</i> (1); 1900; 11/27/07.	σ^a St. <i>humilis</i> (3 r) (THI-C 1); 8/2/00; 5/1/03.
σ^a A 1. 8/2/01; dark (fertile); 11/27/07.	[D 1. 6/5/02; broken.
A 2. 8/4/01; slight development.	[D 2. 6/7/02; broken.
B 1. 4/29/02 } weak shells; broken.	σ^a E. 7/15.....medium dark.....8/1/04.
B 2. 5/1/02 }	F 1. 9/28; killed in nest.
C 1. 5/9.....dark.....5/31/02.	F 2. 9/30; no development.
C 2. 5/11.....light.....5/31/02.	(DD 8, A 12)

Pair 2.

σ^a St. <i>risoria</i> (2); 1900.	σ^a St. <i>humilis</i> (THI-C 2); 1900.
A 1. 8/6/01....dark; dead (?) before 4/1/02.....75 mo.	σ^a E 1. 7/26/02....dark.....1/7/06.....41½ mo.
A 2. 8/8/01....dark; dead (?) before 4/1/02.....75 mo.	σ^a E 2. 7/28/02....dark.....3/5/04 (killed).....19+ mo.
♀ B 1. 4/22.....light.....11/26/04.....43 mo.	F 1. 8/25; not tested.
B 2. 4/24; unhatched.	F 2. 8/27; not tested.
C 1. 6/2; no record.	♀ G 1. 10/11.....light.....10/6/05.....36 mo.
C 2. 6/4; no record.	♀ G 2. 10/13; light.
D. 7/7; no development.	(DD 8, A 12)

TABLE 140.

σ^a St. <i>humilis</i> (THI-3); dead June 1903.	σ^a St. <i>risoria</i> (h. 9); 1899.
σ^a B 1. 5/31/00....darker.....7/10/00.....1½ mo.	M 1. 5/29; hatched; 3/14/05; 45½ mo. (see pl. 22).
♀ B 2. 6/2/00....lighter, fertile. 4/5/06.....70 mo.	M 2. 5/31; probably no development.
♀ C 1. 6/18.....lighter, fertile. alive 1/?/02.....22 mo.	N. 7/5.....hatched.....9/9/03.....26 mo.
σ^a C 2. 6/20.....fertile (pl. 22). 7/4/05.....60½ mo.	σ^a O 1. 8/5.....dark.....2/12/02.....6 mo.
σ^a D 1. 7/23..... <i>risoria-humilis</i> , infertile; 7/25/06. 72 mo.	♀ O 2. 8/7; hatched (weakly fertile with L 2); 9/7/05; 49 mo.
D 2. 7/25; no development.	P 1. 3/25/02; not hatched.
E 1. 8/5; not hatched.	σ^a P 2. 3/27/02....dark ¹.....2/3/04.....22 mo.
E 2. 8/7.....died 10 days old (food ?).....½ mo.	♀ Q 1. 4/29.....dark.....6/21/04.....26 mo.
σ^a F 1. 8/30.....fertile.....5/23/05.....57 mo.	♀ Q 2. 4/31.....hatched.....1/8/04.....20½ mo.
♀ F 2. 9/1.....dark (fertile)....alive 4/?/02.....19 mo.	♀ R 1. 6/2.....hatched.....6/20/03.....12½ mo.
G 1. 12/19; no development.	♂ R 2. 6/4.....hatched.....8/2/03.....14 mo.
G 2. 12/21; no development.	♀ S 1. 7/8.....dark.....alive 3/25/03.....9+ mo.
H 1. 1/10/01; no development.	♂ S 2. 7/10.....dark.....alive 3/25/03.....9+ mo.
H 2. 1/12/01; no development.	♀ T 1. 8/14.....dark.....9/15/03.....13 mo.
I 1. 2/6.....hatched (care ?) 4/4/01.....2 mo.	T 2. 8/16.....dark.....3/25/03; missing.
I 2. 2/8.....hatched.....alive 4/?/01.....2 mo.	♀ U 1. 9/21.....hatched.....1/14/04.....16 mo.
J 1. 2/25.....hatched.....4/8/01.....1½ mo.	U 2. 9/23.....hatched.....alive 3/25/03.....6+ mo.
σ^a J 2/27.....hatched.....11/16/01 (care).	V 1. 1/9/03 } one hatched, lived 2 weeks; other some
K 1. 3/27; not hatched.	V 2. 1/11/03 } development.
σ^a K 2. 3/29.....fertile.....alive 3/1/05.....47+ mo.	W 1. 3/6; no record.
L 1. 4/28; some development.	W 2. 3/8; no record.
σ^a L 2. 4/30; (weakly fertile with O 2); killed 3/28/04; 35+ mo.	(DD 8, DD 10)

¹ The darker and lighter shades were not thus classified during 1902.—ENTRON.

male *risoria* (table 144); more fertile with a male *humilis* (table 145). Two brother-and-sister matings of *humilis-risoria* hybrids are of interest. One pair of hybrids which were themselves hatched from eggs laid toward the extremes of the season (April and August) was very weakly fertile; only one of their eggs hatched in about 18 tests (table 146). The other pair of parents, hatched from eggs (same clutch) laid in June. This pair was much more fertile, hatching 11 young from 34 tests. One of the males of this group (F_2 generation of *humilis* \times *risoria*) is shown in adult plumage and in juvenal plumage in pl. 23. These illustrations will show that there is a greater similarity of the F_2 generation than of the F_1 generation, with the darker species (*St. humilis*). The two dark birds of this fraternity whose sex is known were males; the only light-colored bird whose sex is known was a female.

Is the whole series of developmental stages a series of reversions?¹⁰ If so, then a final stage, which is a case of reversion, must be *arrested development*. The matter is so regarded by Ewart. I think reversions are not arrests, but due to germs of different stamps. Germs of the same bird may be sometimes white, sometimes brown. My experiments in crossing, and the issue of white offspring¹¹ from dark hybrid parents, seem very instructive in this sense.

We do not start with like germs and stop short with one germ, at white for example, and go on with the other to brown. Otherwise the latest stage would be preceded by white; or, if white be the later stage, then it should be preceded by brown, the brown appearing in the first plumage, the white in the second, after the manner of the geopelias.¹² In this case it is not a question of supremacy (prepotency)—a struggle for mastery as Ewart suggests—with victory falling now to the ancestors, now to the moderns, but it is a question of *original constitution*. In the case of these geopelias the germ develops and at one age gives the ancestral color and a little later it gives the final color. (T 22)

TABLE 141.

Pair 1

<i>c</i> Humilis-risoria hyb. (K 2); 3/9/01; reddish isabelline.	
♀ St. alba (O); 9/20/03; white. Purity (?).	
♀ A 1. 7/4/02.	very light pale <i>risoria</i> dead 10/5/04*
♂ A 2. 7/6/02.	very light pale <i>risoria</i> dead 11/27/02
♀ B 1. 8/13.	complexion dark dead 5/23/05
♂ B 2. 8/15.	complexion dark dead 10/23/02
♀ C 1. 2/13/03.	complexion dark (sick, killed); 4/15/05
♂ C 2. 2/15/03.	complexion dark (sick, killed); 7/21/04
D 1. 3/27; not hatched.	
D 2. 3/29.	light <i>risoria</i> dead 4/29/03
E 1. 5/4; deserted.	
E 2. 5/6; deserted.	
♂ F. 5/15.	pale <i>risoria</i> , w. flush of red dead 12/10/04
G 1. 7/7.	<i>risoria-humilis</i> dead 9/26/03
G 2. 7/9.	light <i>risoria</i> dead winter 1903-4

Pair 2

♂ Risoria-humilis (A 1).
♀ St. alba (1); (1901). Purity (?).

A 1. 5/12/02/ one small embryo, one pricked shell. B 1. 5/22; circle of blood.
 A 2. 5/14/02/ no development. B 2. 5/24; no development. (DD 9)

* This and the two following clutches present an interesting situation as regards longevity and sex on the one hand, and of the clutch and sex on the other. Here the *sire* is a hybrid, the dam possibly a hybrid; the more typical relation of

¹⁰ This is the most complete statement I find on the subject of reversion, and it has been thought best to place it here. It was probably written about 1900-1, and apparently as a result of an examination of Ewart's (*The Penyuik Emissaries to Jordan*, 1890) ideas on reversion. *Epigraph.*

¹¹Something of the author's (earlier) idea of "germ differences" is thus included in the discussion of reversion.—EDITOR.

TOR.
See Chapter X. Vol. I.—EDITOR



- A. Adult male F2 hybrid, *St. humilis* × *St. risoria* (D1). Hatched May 4, 1901; age 8 months. $\times 0.6$. Hayashi del., Jan. 1902. Sire, *St. humilis* × *risoria* hybrid (C2), shown in color plate 22, figure B. Dam, *St. humilis* × *risoria* hybrid (C1). The parents were brother and sister. Color a shade darker and size a little smaller than that of parents. Neck-ring rather narrow. Eye-lid pale whitish. Inner circle of iris dusky or hazel; outer one-half or two-thirds dull-brownish orange.
- B. Juvenal male, *St. humilis* × *St. risoria* F2 hybrid (D1). Age 6 weeks. $\times 0.7$. Hayashi del., June 1901. Same bird as adult above, figure A. This bird agrees with its hybrid parents and its pure grandparents in having lighter juvenal and darker adult plumage. See characters of the adult.

TABLE 142.

σ^{α} Humilis-risoria hyb. (D 1); 7/23/00.¹
 φ St. humilis (THI-B 2); 7/7/00.

A. 5/29/02; no development.	C 1. 8/12; dark complexion; probably died early. C 2. 8/14; dark complexion; probably died early.
σ^{α} B 1. 7/9....1 R.....like <i>humilis</i> . φ B 2. 7/11....1 R.....lighter color.	D 1. 10/4; dark complexion, dead 11/5/02. D 2. 10/6; dark complexion, dead 11/5/02. (DD)

¹ The sire (D 1) was previously used as sire in a mating with his hybrid sister (F 2). Only weak-shelled eggs (4) and one 7-day embryo were produced (DD 9).

TABLE 143.

σ^{α} Humilis-risoria hyb. (F 1); 8/30/00; (dark) reddish isabelline.
 φ St. risoria (4) 1900.

A 1. 4/25/01; some development. ¹	σ^{α} and φ K 1. 4/23; color dark; 12/27/04. K 2. 4/25; color dark; 2/14/04.
B 1. 5/8; did not develop. B 2. 5/10; like <i>humilis</i> ; dead 10 days.	L 1. 5/29; did not hatch. Q 1. 2. 5/31; dark; 12/25, 03.
C. 5/29; 7 day embryo.	Q M 1. 6/28 ² one dark; 6/10/05; other failed. M 2. 6/30
D 1. 6/6; no development. D 2. 6/8; no development.	σ^{α} N. 8/15; dark; 8/2/04.
E 1. 7/21; no development. φ E 2. 7/23; like <i>humilis</i> ; alive 3/26/03.	Q O 1. 9/27; like <i>risoria</i> ; 12/18/02. O 2. 9/29; no development.
σ^{α} F 1. 10/26; like <i>humilis</i> ; 10/5/04. σ^{α} F 2. 10/28; like <i>humilis</i> ; alive 3/26/03.	Q P 1. 2/26/03; dark. P 2. 2/28/03; dark; soon died (care).
σ^{α} G 1. 12/17; like <i>humilis</i> ; 10/7/03. σ^{α} G 2. 12/19; like <i>humilis</i> ; killed; ³ 4/30/03.	Q Q 1. 4/15; did not hatch. Q 2. 4/17; did not hatch.
H 1. 2/5/02; 7-10 day development. H 2. 2/7/02; developed to hatching.	R 1. 5/8; deserted. R 2. 5/10; deserted.
I. 3/1; light color; killed; ² 5/3/02.	S 1. 5/23; no record. S 2. 5/25; no record.
σ^{α} J 1. 3/18 ⁴ σ^{α} J 2. 3/20 ⁴ one failed; other σ^{α} color of sire; alive 3/26/03.	(DD 9)

¹ Poor incubation.

² Had weak legs.

TABLE 144.

σ^{α} St. risoria (3); 1900; killed 3/14/05; isabelline as light as mate, no red.
 φ Hum.-risoria hyb. (B 2); 6/2/00; 4/5/06; light hyb., trace reddish.

A. 4/29/01; some development.	K. 6/26; dark (like dam); alive 3/26/03.
B. 5/27; broken.	Q L 1. 7/26 ⁵ one no development. Q L 2. 7/28 ⁵ one like <i>risoria</i> ; dead 11/29, 03.
C. 6/5; developed 4 to 7 day embryo.	M. 9/1; no record.
φ D. 7/8/01; light as sire; ⁴ dead 3/10/04.	Q N. 7/25/03; light; like <i>risoria</i> ; 1. 10/07. Several eggs laid winter and spring, 1904; no record kept.
E 1. 8/5; no development. E 2. 8/7; no development.	O 1. 8/12; no record. O 2. 8/14; no record.
F 1. 10/31; hatched; died same day. F 2. 11/2; trace of development.	P 1. 7/29/04; no development. P 2. 7/31/04; like <i>risoria</i> .
G 1. 2/26/02; developed to hatching. φ G 2. 2/28/02; light as sire; dead 8/9/02.	Q. 8/31/04; 4 R-2 L; light, like <i>risoria</i> .
H. 4/6/02; no development.	R 1. 1/4/05; 4 R-3 L; dark. R 2. 1/6/05; some development (nest bad).
I. 5/2; small embryo. I 2. 5/4; small embryo.	(DD 9)
J 1. 5/20; little or no development. σ^{α} J 2. 5/22; "usual ? hyb. color" (?) medium dark; alive 3/26/03.	¹ All young here called "light" or "risoria-like" have a tinge or cast of red of <i>humilis</i> . (DD 9)

TABLE 145.

Pair 1.

 σ^a St. humilis (3); from dealer 1905; color dark.

♀ Hum. risoria hyb. (C 1); 6/16/99; color lighter than humilis.

σ^a and ♀ A 1. 8/16/05 one (HHR 1— σ^a); nearly color of dam; dead 10/?/07.
 A 2. 8/18/05 one (HHR 2—♀); nearly color of sire; dead 8/20/08; fertile.

B 1. 4/12/06; not well incubated.
 B 2. 4/14/06; not well incubated.

E 1. 3/14/07; not well incubated.
 E 2. 3/16/07; not well incubated.

♀ C 1. 5/21/07 HHR 3.

F 1. 3/30, . . . HHR 6, . . . interm. of dam and sire.
 F 2. 4/1; did not hatch.

σ^a C 2. 5/23/07 HHR 4, . . . killed 7/10/06.

D 1. 9/20/07 HHR 5.
 D 2. 9/22; did not hatch.

G 1. 5/1; did not develop.
 G 2. 5/3; did not develop.

Pair 2.

 σ^a St. humilis (5); 8/15/00; 6/26/04; dark.

♀ Hum.-risoria hyb. (F 2); 9/1/00; dark.

A 1. 5/19/02; no development.
 A 2. 5/21/02; no development.

E 1. 5/3; some development.
 E 2. 5/5; (4 R); dead 12/6/03.

♀ B 1. 7/17 one ♀ (3 R); color of *humilis* ♀; 11/20/03.

F 1. 7/25; no record.

♀ B 2. 7/19 one some development.

F 2. 7/27; no record.

C 1. 8/18; did not hatch.

G. 9/19; no record.

C 2. 8/20; did not hatch.

H 1. 4/8/04; developed to hatching, failed.

D 1. 4/10/03; did not hatch.

H 2. 4/10/04; developed to hatching, failed.

D 2. 4/12/03; dark complexion; died at once.

(A 12, DD 8, DD 9)

TABLE 146.

 σ^a Humilis-risoria hyb. (L 2); 4/30/01; brother.

♀ Humilis-risoria hyb. (O 2); 8/7/01; sister.

A 1. 5/4/02; some development; deserted.

F 1. 10/2; no development.

A 2. 5/6/02; some development, broken.

F 2. 10/4; pricked shell, failed.

B 1. 5/25; no development.

G 1. 10/26; no record; probably not hatched.

B 2. 5/27; developed to hatching; perhaps relieved
too soon.

G 2. 10/28; no record; probably not hatched.

C 1. 7/10; developed near to hatching; died.

H 1. 4/12/03; no record; probably not hatched.
 H 2. 4/14/03; no record; probably not hatched.

C 2. 7/12; developed few days.

I 1. 7/7; developed near to hatching, failed.
 I 2. 7/9; developed near to hatching, failed.

D 1. 7/31; developed few days.

J 1. 9/11; some development.

D 2. 8/2; developed few days.

J 2. 9/13; some development.

E 1. 8/21; did not hatch.

♀ K 1. 10/6} one ♀ (?) hatched dark; other no development.
 K 2. 10/8}

(DD 1, A 12)

TABLE 147.

 σ^a Humilis-risoria (C 2); 6/18/00; lighter, hum.-ris. hyb. (see pl. 22).

♀ Humilis-risoria (C 1); 6/16/00; probably like above.

A 1. 3/21/01; thin, broken; some development.

♀ N 1. 7/17} 3 . . . complexion dark; dead 12/3/02.
 N 2. 7/19} 3 . . . complexion light; dead 1/2/04.

A 2. 3/23/01; thin shell broken.

O 1. 10/12; no record, probably not hatched.

B 1. 3/30; soft shell.

O 2. 10/14; no record, probably not hatched.

B 2. 4/1; soft shell. C. 4/10; no development.

P 1. 3/25/03; developed.

♂ D 1. 4/19, . . . like *humilis* ♀; dead 1/3/03 (see pl. 23).

P 2. 3/27/03; developed. Q. 4/10; no development.

D 2. 4/21; small embryo.

♂ R 1. 4/27, . . . dark (with much red); killed 8/15/04.
 R 2. 4/29, . . . dark; dead 10/25/03.

E 1. 5/16; not hatched.

S 1. 5/30, . . . dark; dead 1/1/04.

E 2. 5/18; not hatched.

S 2. 6/1; no development.

F 1. 7/23; no development.

T 1. 7/28; no record, probably no development.

F 2. 7/25; no development.

T 2. 7/30; no record, probably no development.

♀ G 1. 8/7 one, 7 to 12 day development; one; 2 . . . like

U 1. Spring 1904; no record.

G 2. 8/9} one *humilis*, dead few days.

U 2. Spring 1904; no record.

H. 3/21/02; no test.

V 1. Spring 1904; no record.

I 1. 4/5; small embryo.

V 2. Spring 1904; no record.

♀ J 1. 4/7, . . . 2 . . . risoria-like + reddish. . . 12/5/02.

W 1. 5/10 one = 8; died soon; one, probably no

J 1. 4/23; 6 to 10 day embryo.

W 2. 5/12} development.

J 2. 4/25; 6 to 10 day embryo.

X 1. 7/21} one color of *risoria*; dead at 1 day; one failed.

K 1. 5/13, . . . 4 . . . complexion dark.

X 2. 7/23} one color of *risoria*; dead at 1 day; one failed.

K 2. 5/15; no development.

Y 1. 8/9; probably no development.

L. 6/7; developed (disturbed ?).

Y 2. 8/11; probably no development.

M 1. 7/3 one 1 to 3 day embryo.

M 2. 7/5 one less developed.

(DD 9)

TABLE 148.

Pair 1.

σ^3 Risoria-humilis hyb. (E 1); 7/26/02; dark.	E 1. 5/8/04; no development.
♀ Alba-humilis hyb. ? (C 1); 7/29/02; white.	E 2. 5/10/04; no development.
A 1. 5/11/03; not hatched.	F 1. 6/22; (?) no development.
σ^3 A 2. 5/13/03. RAH-1... complexion dark.	F 2. 6/24; (?) no development.
B 1. 7/8; RAH-2; complexion light.	G 1. 8/5} one, some development; other, none.
B 2. 7/10; no development.	G 2. 8/7}
C 1. 8/8; (?) no development.	
C 2. 8/10; (?) no development.	
D 1. 4/4/04} one no development; RAH-3, dark.	
D 2. 4/6/04	

Pair 2.

σ^3 Alba-humilis hyb. (A 2); 9/29/02; dark.	B 1. 5/24; probably no development.
♀ Risoria-humilis hyb. (B 1); 4/22/01; light.	B 2. 5/26; probably no development.
A 1. 5/1/03; no development.	
A 2. 5/3/03; no development.	

Pair 3.

σ^3 Alba-humilis hyb. (A 2); 6/1/02; dark.	C 1. 9/12; (?) no development.
♀ Alba-humilis hyb. (B 2); 7/1/02; white.	C 2. 9/14; (?) no development.
A 1. 7/9/03; no development.	D 1. 4/7/04; blood circle.
A 2. 7/11/03; no development.	D 2. 4/9/04; no development.
B. 7/27; (?) no development.	
B. Probably no second egg.	(DD 7, DD 9)

TABLE 149.—Reciprocal crosses of humilis-risoria hybrids.

Pair 1.

σ^3 Risoria-humilis hyb. (A 1); 8/2/01; darker, more like <i>humilis</i> .	G 1. 3/27/03; no development.
♀ Humilis-risoria hyb. (N 1); 5/29/01; 3/15/05; (?) less dark, toward <i>risoria</i> .	G 2. 3/29/03; no development.
A 1. 4/28/02; no development.	H. 4/7; some development, deserted.
A 2. 4/30/02; no development.	I 1. 9/14; pricked shell, relieved, (killed).
B 1. 5/11} one (3) complexion dark (soon died); one did	I 2. 9/16; developed to hatching.
B 2. 5/13} not hatch.	J 1. 4/3/04; apparently no development.
C 1. 6/3} one some development; one no development.	J 2. 4/5/04; apparently no development.
C 2. 6/5} one some development; one no development.	K 1. 7/5; no record; probably not hatched.
D 1. 6/30; no development.	K 2. 7/7; no record; probably not hatched.
σ^3 D 2. 7/2; (3) color of dam.	♀ L 1. 7/28; (8) darker than sire (not fertile 3/17/08).
E 1. 8/2; (4) dark complexion; died soon.	L 2. 7/30; probably no development.
E 2. 8/4; not hatched.	
F 1. 9/28} one developed few days; one no development.	
F 2. 9/30}	

Pair 2.

σ^3 Risoria-humilis hyb. (A 1); same as above.
♀ Humilis-risoria hyb. (B 2); 6/2/00; 4/5/06.

A. 4/18/05; near <i>risoria</i> ; killed 5/3/05.	C. 5/30; probably not hatched.
B 1. 4/29; not tested.	
B 2. 5/1; not tested.	

Pair 3.

σ^3 Humilis-risoria hyb. (S 2); 7/10/02; color dark.
♀ Risoria-humilis hyb. (G 2); 10/13/02; color light.

A 1. 11/7/04; color dark; had a defective eye and killed 1/2/05.
A 2. 11/9/04; did not develop.

(DD 7, DD 9, A 12)

Pair 4.—Reciprocal cross of $\frac{3}{4}$ *humilis*- $\frac{1}{4}$ *risoria* hybrids.

σ^3 Humilis-risoria \times humilis hyb. (B 1); 7/9/02; dark, near <i>humilis</i> .
♀ Humilis \times risoria-humilis hyb. (B); 7/18/02; 11/20/03; dark, near <i>humilis</i> .

C 1. 5/30/03; complexion dark <i>humilis</i> -like; soon killed by lice.
σ^3 D 2. 7/11/03; pale gray <i>risoria</i> -like; dead 8/10/03.

(= all of record; A 12)

CROSSES INVOLVING THE SURATE TURTLE-DOVE, AND BLOND, WHITE, AND RED RING-DOVES.

Several of the hybrids whose nature and origin have been discussed in the preceding pages were crossed with other hybrids containing another (dark) species (*Spilopelia suratensis*) of a genus not distantly related. This material may be more appropriately treated here than elsewhere, though the data for the first crosses of *suratensis* are too meager to permit any conclusion as to an association of sex and color in the offspring. There is, however, evidence here to indicate that "white" and "light color" tend to predominate in the season of lowest fertility (weakest germs), and that the late autumn is the period of such lowest fertility. Similarly, there is here further evidence that the very first egg, or clutch, of the season—particularly when this proceeds from quite early in the season—is weaker than the eggs or clutches that succeed it, and that the second eggs of most of the clutches produced by females of pure species have less developmental energy than have the first eggs of the corresponding clutches.

Before proceeding to an examination of the data bearing upon these points it is here appropriate and of interest to note the sex-ratio in these crosses of closely related species. To give a more definite picture of this situation table 156 has been prepared. Only those crosses in which the female was pure, not hybrid, are thus summarized. It will be seen that the proportion of males and females is nearly or quite normal to intra-specific matings, there being 64 males to 59 females. The fact that some of these species are among those most extensively used in the very wide crosses, from which only males arose, makes the sex-ratio noted here of considerable significance. In many of those very wide crosses the blond ring-dove, for example, was used only as female in the pair. It is demonstrated in table 156 that when matings were made of these more closely related species the sex-ratio remained nearly or quite the same, whether the blond ring was used as male or female parent in the cross.

Four species are represented in the final offspring of this group of matings, and 3 species were combined in several different proportions in some offspring. This permitted a study of the fractionation or divisibility of certain of the characters of these species. Full reference to these points is made in Chapter XVII. Illustrations in color of some of these birds may be placed here, however, since they help to make clear some features of the breeding record. The very distinct characteristics of the Surate turtle-dove are displayed in pl. 24.

Crosses of the Surate turtle (see pl. 24) with the blond ring (table 150) and with an *F₂* *risoria* × *alba* hybrid (table 151) show a very high degree of infertility which

TABLE 150.

♂ Sp. <i>suratensis</i> (1); from dealer 9/30/07; alive 5/30/15.	L 1. S/16; infertile.	M 1. S/26; infertile.
♀ St. <i>risoria</i> (757); 7/27/13; alive (tubercular) 2/26/15; (10 clutches before K).	L 2. S/18; 2 to 4 day embryo.	M 2. S/28; infertile.
♂ K 1. 8/10/14; hatched; dead 8/27/14 (cause ?).	O 1. 9/14; infertile.	P 1. 9/25; infertile.
♀ K 2. 8/12/14; hatched; dead 8/28/14.	O 2. 9/16; infertile.	P 2. 9/27; infertile.
♀ N 1. 9/5; hatched.....124.....alive 3/1/15.	T 1. 11/11.	(all infertile.)
N 2. 9/7; infertile.	T 2. 11/13.	(all infertile.)
Q 1. 10/8.	S 1. 10/30.	V 1. 12/30; infertile.
Q 2. 10/10.	R 1. 10/20.	V 2. 1/1/15; infertile (dam tubercular, 1/1/15).
?♀ U 1. 11/26; full term embryo.	S 2. 11 1.	(O. R.)
?♂ U 2. 11/28; full term embryo.		



Adult Surate turtle-dove, *Spilopelia suratensis*. $\times 0.7$. Hayashi del.

The full dark centers of the feathers, as seen in *Turtur orientalis*, are here replaced by mesial stripes. Three feathers from neck-mark show divided tips, dark basal parts, and white or brown tips.



- A. Adult male, *St. alba-risoria* × *St. risoria-alba*. Hybrid (E2 of table 131). From egg of Sept. 21, 1897; alive Oct. 1904. $\times 0.5$. Hayashi del., Feb. 1902. General coloration distinctly lighter than that of the blond ring (see plate 8). The effect of the white ring (*St. alba*) is further seen in the very light quills of the wing plumage, and in the increased white edging to the feathers of neck-mark. This sturdy individual mated with a homer, a Chinese turtle, and with three ring-doves.
- B. Adult male ring-dove × Surate turtle-dove. Hybrid (F). Hatched Sept. 25, 1889. $\times 0.5$. Hayashi del. Sire, *St. alba-risoria* × *risoria-alba* (D2, color of blond ring). Dam, *Spilopelia suratensis*. Note reduction (from *suratensis*) of area of neck mark, the divided feather-tips (three separate feathers); also lighter general color and reduced mesial stripes. See neck-mark in plate 34, figure 4.

TABLE 151.

σ^{α} alba-ris. \times ris.-alba hyb. (D 2); 7/24/97; (brown).	σ^{α} F 1. 9/13/99; hatched (<i>F-O</i>); mated ¹ to 5 ♀'s; alive 2/19/08 (see pl. 25).
♀ Sp. suratensis; prob. imported 1897; dead 7/20/00.	F 2. 9/15/99; no development.
A 1. 4/11/99; no development.	G 1. 9/5; no development.
A 2. 4/13/99; no development.	G 2. 9/7; no development.
B 1. 4/26; no development.	H 1. 10/19; no development.
B 2. 4/28; no development.	H 2. 10/21; no development.
C 1. 6/5; no development.	I 1. 11/6; no development.
C 2. 6/7; no development.	I 2. 11/8; no development.
D 1. 6/28; no development.	J 1. 12/1; prickled shell, died.
D 2. 6/30; no development.	J 2. 12/3; no development.
E 1. 8/1; no development.	
E 2. 8/3; no development.	

(DD 4)

¹ The single offspring from the above cross was mated successively with five different females and became the sire of an interesting progeny. This breeding record is detailed in tables 152, 153.

TABLE 152.

σ^{α} alba-ris. \times ris.-alba \times suraten. hyb. (F-O); 9/13/99; alive 1908; dark (pl. 25).	
♀ St. alba; (1902 ?); white.	
A 1. 4/8/03; some development.	
A 2. 4/10/03; hatched; complexion <i>dusky</i> ; dead at 1 day.	
σ^{α} B 1. 5/1.....T 1.....color pale <i>risoria</i> (see pl. 26).	
♀ B 2. 5/3.....T 2.....darker <i>risoria</i> than B 1; pupil central.	
♀ C 1. 6/5.....T 3.....dark as sire; pupil central (nearly).	♀ E 1. 8/22{ one (♀ T 5) light as <i>risoria</i> ; other failed
C 2. 6/7; few days development.	E 2. 8/24{ one (♀ T 5) light as <i>risoria</i> ; other failed
σ^{α} D 1. 7/14.....T 4.....nearly dark as sire; fertile.	F 1. 9/29; no development.
D 2. 7/16; no development.	F 2. 10/1; no development.
G 1. 2/18/04; no development.	H 1. 3/28; dark complexion; killed in nest.
G 2. 2/20/04. T 6.....complexion light <i>risoria</i> .	H 2. 3/30; dark complexion; thrown from nest, killed

(DD)

TABLE 153.

σ^{α} alba-ris. \times ris.-alba \times suraten. hyb. (F-O) same as above; 127+ mo., dark.	
♀ alba-humilis hyb. (E 2); 10/1/02; 10/15/05; 36½ mo.; white.	
A 1. 6/3/04; no development.	B 1. 7/2/04; no development.
A 2. 6/5/04; no development.	B 2. 7/4/04; no development.
♀ St. <i>risoria</i> , 1903, given 8/20/04; typical blond ring.	
A 1. 8/24/04{ one, hatched; complexion dark <i>risoria</i> ; dead (lice) at 1 day; other, no development.	
A 2. 8/26/04{ one, hatched; complexion dark <i>risoria</i> ; dead (lice) at 1 day; other, no development.	
♀ St. humilis (4) given 5/27/05; dead 2/?/06.	
A 1. 6/15/05; no development.	B 1. 7/?/05; no development.
A 2. 6/17/05; no development.	B 2. 7/?/05; no development.
σ^{α} C 1. 8/11.....RSH 1.....color of <i>ris.-humilis</i> ♂.	
C 2. 8/13; no development.	

This ♂ refused to accept other ♀'s offered him till ♀ St. alba (from dealer, probably 1905) given Sept. 1906.

A 1. 9/18/06; no development.	
A 2. 9/20/06; no development.	
σ^{α} B 1. 9/24.....RS-A 1.....pale, very light <i>risoria</i>.....dead 4/10/09.....30½ mo.	
B 2. 9/26; no development.	
♀ C 1. 2/14/07.....RS-A 2..... <i>risoria</i> nearly .....dead 12/22/08.....22 mo.	
C 2. 2/16/07; no development.	
σ^{α} D 1. 3/24.....RS-A 3.....darker than RS-A 2.....dead 6/28/10.....39 mo.	
D 2. 3/26; no record, probably not hatched.	
E 1. 4/26; no development.	F 1. 6/?; no development.
E 2. 4/28; no development.	F 2. 6/?; no development.
G 1. 8/1; hatched, diminutive <i>risoria</i> ; dead (lice) at a day.	
G 2. 8/3; no development.	
H 1. 8/25.....RS-A 3-R.....complexion dark.....dead before 2/5/11.	
H 2. 8/27; no development.	
σ^{α} I 1. 10/10.....RS-A 5.....complexion dark, dead (lice) at 12 days.	
σ^{α} I 2. 10/12.....RS-A 6.....complexion dark, dead (lice) at 12 days.	
J. 2/19/08; no development.	

(DD)

is doubtless partly accounted for by the fact that in each case one parent died at or near the close of the breeding period. From the latter cross a single bird matured. This male (*F-0*), though of general dark color, was a true intermediate to his ring-Surate parents in color and color-pattern characteristics, as is well shown in pl. 25. He was mated to 5 different females, as indicated in tables 152 and 153. When 4 to 5 years old and mated to a *St. alba*, half of the eggs produced were hatched; at 7 to 8 years old, with another *alba*, only 7 of 19 eggs were hatched. With an *alba-humilis* hybrid—a group elsewhere noted to be of low fertility—there was no trace of development in any of 4 tests. With *St. risoria* 1 young hatched from 2 tests; and with *St. humilis* 1 young hatched from 6 tests. It is clear therefore, that this bigeneric hybrid did not possess full fertility with 2 of the 3 parental species, nor with a third one related to them.

One of the offspring of the above-described male (*F-0*) and a *St. alba* female is shown in color in pl. 26. Its color is several grades lighter than that of the sire. Some of this fraternity were, however, darker than this individual. There was in this family no limitation of color by sex; there were darker and lighter males, as well as darker and lighter females. The pale-colored male just referred to in the plate was crossed with a *humilis-risoria* hybrid (table 154), which was darker than the mate in color, and with this bird threw several "white" young (5 of 13), in addition to two or three different darker shades of young. One of the darker of these dark offspring is reproduced in pl. 26. This interesting bird is a hybrid of 4 species belonging to two genera.

We may now return to a consideration of other features of the breeding data. The results from the mating of the male (*F-0*) with the pure white rings deserve a further word. This male was $\frac{1}{4}$ *alba*, $\frac{1}{4}$ *risoria*, $\frac{1}{4}$ *suratensis*, and sired 16 young from the two matings with female *St. alba*; there were, however, no white offspring. The tendency toward *suratensis* color in these young is clear in about 9 cases; a tendency toward *risoria* is shown in about 7 individuals. In this case, as previously noted with *orientalis*, *risoria*, and *humilis*, the species *alba*, when used as dam, only slightly modifies the color of the young of the *F₁* generation.

In the first mating of this same male with *St. alba* (table 152) it is clear that the late autumn is the period of least developmental capacity for the germs, and that

EXPLANATION OF PLATE 26.

- A. Adult male complex hybrid (TH 7). Hatched Apr. 19, 1905. Six-tenths natural size. Hayashi del., July 1906.

Four species are represented in this hybrid: *St. alba* has entered three times (=5/16). *St. risoria* has entered three times (=5/16). *Spil. suratensis* has entered once (=2/16). *St. humilis* has entered once (=4/16). The sire is shown in color below, fig. B; neck-mark in pl. 34. The dam was a *St. humilis* × *St. risoria* hybrid (O 2) of dark color.

The size of TH 7 is about the same as that of *St. risoria* × *St. humilis* hybrids, or a trifle smaller. The color strongly resembles a male *St. risoria* × *St. humilis* hybrid, but with a weak *suratensis* mark (mesial stripe), which is about the same as that of the first *risoria* × *suratensis* hybrid. The mesial stripes of the sire (T 1) are very faint in this bird; this is caused not by a direct effect on the region of the mark, but by a strengthening of the pigmentation as a whole. The neck-mark is now practically that of 14/16 of the ancestry.

- B. Adult male *Streptopelia risoria* (1/8) — *Spilopelia suratensis* (1-4) — *St. alba* (5-8) hybrid (T 1). Hatched May 16, 1903. Six-tenths natural size.

Sire, shown in color, pl. 25, fig. B. Dam, *St. alba* (1902).

Note another degree of "lightening" of the *Spil. suratensis* color, through a second ring-dove cross. The area of the neck-mark is further limited, and once more approaches the proportions found in the ring-dove. A slight division of the feather-tip persists.



A. Adult male complex hybrid (TH7). Hatched Apr. 19, 1905. $\times 0.6$. Hayashi del., July 1906.

B. Adult male, *Streptopelia risoria* ($\frac{1}{2}$) \times *Spilopelia suratensis* ($\frac{1}{4}$) \times *St. alba* ($\frac{1}{8}$). Hybrid (T1). Hatched May 16, 1903. $\times 0.6$.

this period is immediately preceded and followed by a predominance of light-colored offspring; while in both the preceding and succeeding spring-time there is a period in which dark color predominates. In the second mating with *alba*, the very first and last eggs of the two seasons show infertility (3 cases) or light color (1 case). The more infertile period here, however, would seem to be May or June. In this last mating the first egg showed greater developmental capacity in 5 cases, less in none. In the earlier cross with *alba*, 2 cases followed the rule and there were 2 exceptions; both of these latter, however, were found in the *first* clutches of the two seasons embraced by the mating period. The earlier matings of this series—pure *risoria* and *suratensis* females—show first eggs of pairs as more fertile in 3 cases, less fertile in 1 case. Two further illustrations of and no exceptions to this rule are given by another *St. alba* female whose record is placed in table 154.

The bearing of season and fertility upon the dominance of light or dark color may be further noted by reference to the first part of table 154. It will there be

TABLE 154.

σ^{α} *alba-ris.* \times *ris.-alba* \times *suraten.* $\times \times$ *alba* hyb. (T 1); 5/1/03; pale *risoria* (see pl. 26).
 ♀ *humilis-risoria* hyb. (O 2); 8/7/01; 9/7/05; 49 mo.; darker than above.

σ^{α} A 1. 6/21/04 TH 1 color <i>dark</i> ; fertile with <i>risoria</i> (1 pale, and 1 dark σ^{α} offspring).
A 2. 6/23/04 TH 2 <i>dark</i> ; toward <i>humilis</i> .
B 1. 7/10; complexion and down indicated <i>dark</i> color like A 1 and A 2; dead (out of nest) at 3 days.
B 2. 7/12; very small—to be <i>white!</i> dead (out of nest) at about 1 to 2 days.
C 1. 8/2 TH 3 complexion and down <i>dark</i> , like <i>humilis</i> .
C 2. 8/4; color <i>white!</i> dead (out of nest) at about 10 days.
D 1. 8/30; small <i>white!</i> died (lice) at 1 day.
D 2. 9/1; larger light grayish brown; toward earlier darker young; dead at 18 days.
E 1. 9/27; no development.
E 2. 9/29 TH 4 color <i>white!</i>
F 1. 10/31 TH 5 <i>light pale risoria</i> ; dead "autumn 1904."
F 2. 11/2; no development.
G 3/14/05; color to be <i>white!</i> dead (thrown from nest) at 1 day.
σ^{α} H 1. 4/4 TH 6 <i>dark</i> ; toward <i>humilis</i> and <i>suratensis</i> (fertile w. <i>alba</i>); 8/14/08 40 mo.
σ^{α} H 2. 4/6 TH 7 <i>dark</i> , <i>suratensis</i> streaks less strong than TH 6 (see pl. 26); matured (G 8)

σ^{α} TH 6 above = *alba-ris.* \times *ris-alba* \times *surat.* $\times \times$ *alba* $\times \times \times$ *hum.-ris.* (hyb.); 4/4/05; 8/14/08; 40 mo.; *dark*.
 ♀ *St. alba*; from dealer 1906; *white*.

σ^{α} A. 5/15/06 TH 6-A color <i>dark</i> , near <i>douraca</i> ¹ dead 2/12/08 21 mo.
B 1. 9/5) one developed to hatching, failed; light down, and complexion of <i>risoria</i> ; one, no development. B 2. 9/7)
C 1. 4/6/07 TH 6-C <i>risoria-like</i> , w. trace reddish (of <i>humilis</i>); dead 12/6/07 8 mo.
C 2. 4/8/07; no development.
D 1. 2/5/08 TH 6-D <i>pale light risoria</i> 12/8/09 22 mo.
D 2. 2/7/08; developed to hatching, failed; complexion <i>light risoria-like</i> .
E 1. 3/7/08; no development (lack of care of σ^{α} ? and cold?).
E 2. 3/9/08; no development (lack of care of σ^{α} ? and cold?).

σ^{α} TH 6-A above; 5/15/06; 2/12/08 (tuberculosis); 21 mo.; *dark*.
 ♀ *St. alba* (1); from dealer 1906; *white*.

♀ A. 9/15/07 TH 6-A-A <i>white</i> ; fertile alive 4/14/09 19+ mo.
(G 8, DD)

¹ Japanese rings and blond rings had access to the nest of this pair. It was at first thought that a *douraca* may have left there the egg that hatched this bird; but this consideration was later overruled.—EDITOR.

seen that in this mating the parents are both "hybrids" and that a predominance of dark color resulted from the "strong germs" of the spring, and a predominance of white or of light color from the "weaker germs" of the late season and "out-season." The period of white and pale color is here clearly seen to be the season of greatest infertility.

A case quite like this, but even more diagrammatic in its representation of the relation of color-dominance to season and fertility, is recorded in table 155. This case was separately transcribed by the author from the breeding record and given the following comment. It seems best to present this comment in quite the original form:

White coming in at end of season:

○ RS-A3—color dark as a Japanese ring,
○ TH 6-A-A—color white.

These birds in 1908 had the following young:

- A. hatched 6/5, dark as sire.
 B 1. hatched 7/10, dark as sire.
 B 2. hatched 7/10, *rina-dove* color.

C 1. hatched 8/22, white!
 C 2. no development.

D 1. laid 9/11, no development.
 D 2. laid 9/13, no development.

Laid once or twice more during autumn, but no development. The color began with dark, later became *blond* ring, later, *white*; still later, *no development*. (B 16)

The sex-ratio obtained from the several matings of non-hybrid females with males of closely related species, considered in this chapter, is summarized in table 156. It will be noted that the ratio is normal and that few of these young were produced from eggs laid at an abnormally rapid rate. Some of the species involved in these crosses with closely related species, and yielding here a normal or nearly normal sex-ratio, are the same species which have earlier been noted to throw very high proportions of males when mated with very distantly related species.

TABLE I55.

σ^a $\frac{1}{2}$ alba- $\frac{1}{4}$ ris.- $\frac{1}{4}$ surat. hyb. (RS-A 3); 3/24/07; 6/28/10; 39 mo.; dark as douraca.
 $\frac{1}{2}$ ris.- $\frac{1}{4}$ surat.- $\frac{1}{4}$ lum. $\frac{1}{4}$ alba (TII 6-A-A) (see note); 9/15/07; white.

- | | |
|--|------------------------------------|
| A. 4/11 08; no development (this egg from mating with brother (RS-A 1) of above ♂). | |
| ♂ A. 5/20 08 . . . RS-TH-A . . . nearly color of sire; <i>dark</i> | dead 8/13/08 12 wks. |
| ♂ B 1. 6/24 RS-TH-B- <i>r</i> . . . trace lighter than sire; <i>dark</i> | dead 9/30/08 14 wks. |
| B 2. 6/26 RS-TH-B-L . . . like <i>risoria</i> — <i>pale</i> . | |
| ♂ C 1. 8/6 RS-TH-C . . . white! | dead 1/1/10 17 mo. |
| C 2. 8/8; no development. | |
| D 1. 9/11; no development. | (Some later eggs; no development.) |
| D 2. 9/13; no development. | |

E 1. 4/12/09 . . . RS-TH-E . . . color of sire, *dark*.
E 2. 4/14 '09: developed to hatching, failed; opened, found dead; *white*.

(D11)

NOTE.—"It is possible that *TH* 6-A—the sire of *TH* 6-A-A—is a hybrid between the common ring (*St. risoria*) and the Japanese ring (*St. dorsuca*). I had Japanese rings (2), and common rings in the yard, and they may have mated and laid an egg in the nest of ♂ *TH* 6 (mated with a ♀ *alba*). This possibility I should not think of except that *TH* 6-A had the color and form of such a hybrid, and his voice was that of such a hybrid—strongly resembling a Japanese ring's voice. Even *TH* 6-A-A, although white, yet has a voice that strongly reminds of the Japanese ring. Still I have to hold to the above composition." Later Professor Whitman said (G S): "I now think that this resemblance of voice to that of the Japanese ring comes through *suratensis*. The syllables are the same in number as in *suratensis*—and the quality and rhythm are similar, though plainly distinct."

TABLE 156.—*Sex-ratio from nonhybrid females crossed with related species.*

Cross.	♂	♀	Cross.	♂	♀	Cross.	♂	♀
♂ risoria	10	7	♂ ris.-douraca	3	4	♂ ris.-alba	2	3
♀ douraca			♀ risoria			♀ douraca		
♂ humilis	11	12	♂ hum.-risoria	7	6	♂ hum.-risoria	1	1
♀ risoria			♀ risoria			♀ humilis		
♂ risoria	4	3	♂ alba-ris. hyb. ¹	1	0	♂ alba	18 ²	18
♀ humilis			♀ suratensis			♀ humilis		
♂ suratensis	2	3				♂ trispecific hyb.	7	5
♀ risoria						♀ alba		
Total	27	25	Total	11	10	Total	28	27

¹This bird is *alba-risoria* \times *risoria-alba*.²Color indicates 18 males; 11 were known to be males.

CHAPTER XIII

OTHER PIGEON HYBRIDS AND THE BREEDING OF SEVERAL PURE SPECIES OF DOVES AND PIGEONS.

There remains for presentation the data for a few crosses of pigeons belonging, for the most part, to groups not hitherto considered. It is also desirable to treat here some data upon the breeding, apart from crossing, of pure wild forms (with one exception). Excepting a relatively small amount of data upon hybridization and simple breeding, which it is quite necessary to place in Volume I of these works, all of the author's results in this field are included in this volume and concluded in the present chapter.¹

The materials now to be considered offer further evidence upon many of the topics which have formed the centers of interest throughout the previous pages. Such topics touched upon by these data may be enumerated: (1) the exclusively male offspring of crosses of most widely separated species; (2) the lower percentages of males from less widely separated crosses; (3) relatively large numbers of infertile eggs from the wide crosses; (4) a restricted life-term for many or most of the embryos and offspring of the widest crosses; (5) abnormally sexed individuals from hybrid parents; (6) weaker germs from the end of the season; (7) a case of the reversal of dominance of color at the end of the season; (8) the predominance of males from the first egg of the clutch in crosses; and (9) also in some pure-bred species. Some hitherto unconsidered data on the breeding of certain pure forms, on the incubation period, on the time between the 2 eggs of the clutch, and between different clutches, are also given in the second part of the chapter.

SEVERAL CROSSES OF DOVES.

It is found convenient to treat 8 crosses or kinds of crosses separately.

Senegalensis \times *alba*.—These two birds belong to different genera. *Stigmatopelia senegalensis* is a smaller dove than the blond and white rings with which it was crossed. An adult male of this delicate and very distinct species is shown in pl. 27. Two of three *Senegal* \times blond matings proved fully fertile (table 157); the pair that showed a limitation upon fertility produced all of its eggs in late summer. The female offspring are notably smaller than the males; and this is apparently true also when the blond ring is used as the female in the cross.

A brother-and-sister mating of these hybrids was largely infertile (table 158), though 3 other males of this fraternity were almost fully fertile when mated to pure *St. risoria* (table 159); and a fourth male proved similarly fertile with *Spil. suratensis* (table 164). The mating with *risoria* yielded (pair 3) from the last egg of the season an abnormally sexed individual. Pair 1 produced 12 eggs; 10 were tested and all were hatched. The 6 eggs laid before July 5 all hatched birds of dark, *risoria*-like color; the bird from the seventh egg (August 1) was "grayish, nearly white"; its clutch-mate was "white"; the ninth egg (September 6) hatched "white"; the

¹ Numerous records of little consequence, of matings of very short duration, and data not full enough to have significance have, of course, not been presented. All matings giving an adequate or significant test of complete infertility have been specially listed in Chapter II. The textual statement of the present chapter was written by the editor.



Adult male Senegal turtle-dove, *Stigmatopelia senegalensis*. Natural size. Hayashi del., Mar. 1908.
The tail is here shown somewhat expanded. The separate bifurcated feather (with tip) is from the neck-mark ;
it is nearly of the general body color. Natural size.

young from the tenth and last egg "died early," before the color of its plumage was learned, but the complexion and down seemed nearly like the blond ring. At this point the author writes on the margin of the record—"weakness at end of season"!

Senegalensis × *risoria*.—The offspring of this cross gave evidence of a sex-limited inheritance of color; the "color of the female is a slight shade darker² than the male; the male has rather more of the vinous tinge on the breast. The orange color of the iris is of deeper color in the female than in the male." (K 8) Three pairs of the primary cross, Senegal × blond, showed fair fertility (table 160). Two of the F₁ males tested fully fertile—one with pure *alba* (table 161), the other with pure *risoria*³

TABLE 157.

Pair 1.	Pair 2.
♂ Stig. <i>senegalensis</i> (1).	♂ Stig. <i>senegalensis</i> (2).
♀ St. <i>alba</i> ; age unknown.	♀ St. <i>alba</i> (91); age unknown.
A 1. 7/20/08 one developed near to hatching; other apparently did not develop.	♂ A 1. 4/15/09... TS-A 3... 157 g.; dead 11/26/11.
A 2. 7/22/08	♂ A 2. 4/17/09... TS-A 4... (starved ?); 11/27/09.
♂ B 1. 8/14.... TS-A 1.... 2/29/11; fertile. ¹	♀ B 1. 5/17.... TS-A 5.... dead (food ?); 11/29/09.
B 2. 8/16; no development.	B 2. 5/19.... TS-A 6.... dead in nest.
C 1. 9/17; developed; deserted.	
C 2. 9/19; developed; deserted.	
	(AA 2)
Pair 3.	
♂ Stig. <i>senegalensis</i> (11).	
♀ St. <i>alba</i> ; age unknown.	
♂ A. 4/5/09.... TS-A 2.....	dead (starved) 11/28/09..... 8+ mo.
♂ B 1. 6/1.... TS-A 7.... 143 g.....	fertile ² dead 9/23/14..... 64 mo.
♂ B 2. 6/3.... TS-A 8.... 135 g.....	fertile..... disappeared 7/5/11-11/4/13..... 25+ mo.
♂ C 1. 8/15.... TS-A 9....	dead (starved) 11/28/09..... 3½ mo.
♀ C 2. 8/17.... TS-A 10.... 118 g.....	fertile..... dead 2/5/12..... 30 mo.
♂ D 1. 9/1.... TS-A 11.... 154 g.....	fertile..... dead 10/9/11..... 25 mo.
♀ D 2. 9/3.... TS-A 12.... 119 g.....	dead 8/19/10..... 11½ mo.
♂ E. 10/4.... TS-A 13.... 144 g.....	fertile..... dead 7/10/11..... 21 mo.
♀ F 1. 5/21/10.... TS-A 14....	dead 1/16/12..... 20 mo.
♂ F 2. 5/23/10.... TS-A 15....	dead 2/13/12..... 21 mo.
♀ G 1. 6/15.... TS-A 16....	dead 2/13/12..... 20 mo.
♀ G 2. 6/17.... TS-A 17....	dead 2/6/12..... 19½ mo.
	(P 8, K 8)

¹ Weight of ♂ TS-A 1, 149 g.

² Fertile with *Sp. suratensis*.

TABLE 158.

♂ <i>seneg.-alba</i> hyb. (11); 9/1/09; 10/9/11; 25 mo.; brother.	B 1. 5/21; no development. ¹
♀ <i>seneg.-alba</i> hyb. (10); 8/17/09, 2/5/11; 30 mo.; sister.	B 2. 5/23; no development.
A 1. 4/30/10; some development; failed (cold ?)	
A 2. 5/2/10; some development; failed (cold ?).	
C 1. 6/11} one failed; other hatched, 2 TSA 1; juvenil feathers quite dark; dead 11/25/10 to 2/5/11; ? 7 mo.	
C 2. 6/13}	
♂ D 1. 7/9.... hatched..... 2 TSA 2 color same as 2 TSA 1; dead 11/26/11.....	16 mo.
D 2. 7/11; no development.	
E 1. 8/29; no development.	
E 2. 8/31; no development.	

(AA 6)

¹ "Fertility. We see in this pair a lower fertility than when one of the hybrids is mated with a ring-dove. The optimum usually reached about the end of May, and runs through June and July." (AA 6)

² The complexion of the Senegal dove at hatching is perceptibly darker than that of the blond ring; the darker shade of the F₁ female is similar to that of her sire.—EDITOR.

³ From the latter mating 2 birds are still alive at 5 years old; but a much-sought adequate test of their sex has thus far not been obtained. They lay no eggs, fertilize no eggs, and fight almost continually; they may prove to be hermaphrodites.—EDITOR.

TABLE 159.

Pair 1.

σ^3 A 1. 5/15, 09.....	TS-A-R 1.....	144 g.....	dead 8/1/10; dark like <i>risoria</i> .
A 2. 5/17, 09.....			dead hatching (injured ?); complexion dark.
σ^3 B 1. 7/3.....	TS-A-R 3.....	151 g.....	dead 12/26/10; dark like <i>risoria</i> .
σ^3 B 2. 7/5.....	TS-A-R 4.....	157 g.....	dead 8/19/10; dark like <i>risoria</i> .
C 1. 5/5/10; laid out of nest.			
C 2. 5/7/10; laid out of nest.			
σ^3 D 1. 6/4.....	TS-A-R 5.....		killed in experiment 3/18/14; dark like <i>risoria</i> .
σ^3 D 2. 6/6.....	TS-A-R 6.....		dead 1/14, 11 or 1/27, 12; dark like <i>risoria</i> .
σ^3 E 1. 8/1.....	TS-A-R 10.....		dead 12/30/11; grayish, nearly white.
♀ E 2. 8/3.....	TS-A-R 11.....		dead 9/15/10; white.
F 1. 9/6; developed nearly to hatching, died; white. ¹			
F 2. 9/8.....	TS-A-A 17.....		died early, complexion and down nearly blond ring. (AA 3)

Pair 2.

σ^3 seneg.-alba hyb. (TS-A-S) 6/3/09.			
♀ St. risoria (139); no data.			
A 1. 5/4/10.....	TSAR 7.....		dead 5/2/11; as dark as <i>douraca</i>
A 2. 5/6/10.....	TSAR 8.....		as dark as <i>risoria</i> .
σ^3 B 1. 6/16.....	TSAR 9.....		dead 1/14/11 or 1/27/12; (juvenile) roseate blond.
B 2. 6/18; did not hatch.			
σ^3 C 1. 7/15.....	TSAR 14.....		killed 10/6/13; (juvenile) soft ruddy blond.
σ^3 C 2. 7/17.....	TSAR 15.....		dead 1/18/14; (juvenile) darker than C 1, more like <i>senegalensis</i> .
D 1. 9/2.....	TSAR 18.....		probably died early.
D 2. 9/4.....	TSAR 19.....		probably died early. (AA 4)

Pair 3.

σ^3 seneg. \times alba hyb. (13) 10/4/09; 7/10, 11; 21 mo.			
♀ St. risoria (O).			
A 1. 5/26/10; one hatched = TSAR 9 σ^3 ; dead 1/14/11; other some development.			
A 2. 5/28/10.....			
σ^3 B 1. 6/28.....	TSAR 12.....		dead 1/8/12; ruddy brown.
? ♀ B 2. 6/30.....	TSAR 13.....	(sex ?) ²	dead 1/31/12; dark grayish brown. (AA 5)

¹ "Weakness at end of season." (AA 3.)² Sex-glands abnormal; a right gland affected with tumor, ovarian-like; but no trace of a left gonad.—EDITOR.

TABLE 160.

Pair 1.

σ^3 Stig. senegalensis (1).			
♀ St. risoria; dead 6/15, 09.			
♀ A 1. 3/2/09.....	TS-R 1.....	119 g.....	C. 5/25.....
A 2. 3/4/09; hatched; died early (care).			TS-R 4..... died early.
σ^3 B 1. 4/10.....	TS-R 2.....	142 g.....	dead 2/26/11..... 22 mo.
♀ B 2. 4/12.....	TS-R 3.....	134 g.....	disappeared 2/1/11 to 11/4/13..... 22 to 55 mo.

Pair 2.

σ^3 Stig. senegalensis (1).			
♀ St. risoria (no mark).			
Some eggs laid before following.			
A 1. 2/4/10.....	TS-R 5; died early (care).		σ^3 C 1. 6, 5..... TS-R 7..... dead 3/3/13.
A 2. 2/6/10; probably did not hatch.			σ^3 C 2. 6/7..... TS-R 8..... dead 3/25/12.
B 1. 3/9; did not hatch.			♀ D 1. 7/20..... TS-R 9..... dead 1/18/12.
B 2. 3/11.....	TS-R 6; disappeared 7/5/11 to 11/4/13.		σ^3 or σ^3 ♀ D 2. 7/22..... TS-R 10..... alive 10/1/14.

Pair 3.

σ^3 Stig. senegalensis; (no mark).			
♀ St. risoria (O); has a yellow eye.			
σ^3 A 1. 4/28/09.....	TS-R 20.....	143 g.....	C 1. 7/13; probably did not hatch.
σ^3 A 2. 4/30/09.....	TS-R 21.....	127 g.....	C 2. 7/15; probably did not hatch.
B 1. 6/4; probably did not hatch.			σ^3 D. 8/8..... TS-R 22..... 131 g..... dead 11/28/11.
B 2. 6/6; probably did not hatch.			(AA 2, K 8)

¹ Has a pale yellow eye; fertile with St. risoria.

(table 162). The data for fertility of the Senegal \times blond and white ring crosses, both in the primary cross and in the resulting hybrids, is therefore higher than will be found in the *family* cross next to be considered. It will soon appear that the *sex-ratio* from the two groups of crosses—genera and family—furnishes a parallel to this difference in fertility. Where infertility is greatest, and the cause of this infertility is width of cross, the ratio of males to females is also highest (table 167).

Migratorius \times risoria and alba-risoria hybrids.—Two crosses of these forms, which are separated by differences of *family* rank, showed a high percentage of infertility; several embryos incapable of hatching were formed; and a notable fraction of the young died very soon after hatching. The 8 offspring which survived were all males (table 165).

The male species concerned in this mating is the now extinct wild American passenger-pigeon. The above-described hybrids, together with the two listed immediately below, are perhaps the only known hybrids of this remarkable species. The male passenger-pigeon is shown in pl. 28, the female in pl. 29, and one of the hybrids from the *migratorius \times alba-risoria \times risoria-alba* cross is also shown in pl. 30. The intermediate nature of the hybrid becomes clear from an inspection of the illustration. This topic is further discussed in Chapter XVII.

Migratorius \times alba.—This record is short, though similar to the preceding. Two males were produced. The very first egg of the series and the last 3 of the season were wholly infertile.

Miscellaneous crosses.—The three crosses listed in table 166 require but little additional discussion. The *damarensis \times risoria-alba* cross (pair 1) is a mating of related species, and the fertility seems high and the term of life moderately long. The *chinensis \times suratensis* mating (pair 2) is also one between related species of the genus. The fertility record here falls below that of the preceding cross, and the term of life of the offspring is shorter. The *leuconota \times livia* cross (pair 3) tells us only that offspring may be had from this cross. The last of these crosses (pair 4 of table 166) supplied more adequate tests and is of greater interest. The genera involved in that cross—*Melopelia* and *Streptopelia*—belong to different subfamilies, and the table indicates again the very high degree of infertility of such crosses. Only three birds were hatched from the 18 or 20 tests; there were produced, more-

TABLE 161.

♂ Seneg.-risoria (TS-R 2); 4/10/09; 2/26/11; 22 mo.
♀ St. alba; age unknown.

- | | | |
|-------------------|-------------|---|
| A 1. 5/15/10..... | TSRA 1..... | disappeared 2/5/11 to 11/4/13. |
| B 1. 7/24..... | TSRA 2..... | darker than B 2; disappeared 7/5/11 to 11/4/13. |
| ♀ B 2. 7/26..... | TSRA 3..... | light ruddy blond; dead 5/7/13. |
- (AA 6)

TABLE 162.

♂ Seneg.-risoria hyb. (22); 8/8/09; 11/28/11; son; pale yellow eye
♀ St. risoria (O); age unknown; dam; yellow eye.

- | | | |
|-------------------|--------------|---|
| A 1. 4/16/10..... | TS-RR 1..... | disappeared 7/5/11-11/4/13 (or, died ? ♀ 7/28/13; darker than A 2). |
| A 2. 4/18/10..... | TS-RR 2..... | disappeared 7/5/11-11/4/13 (or, is ♂ or ♂ ♀ alive 10/1/14; lighter than A 1). |
| B 1. 5/29..... | TSRR 1..... | disappeared 7/5/11-11/4/13 (or, died ? ♀ 7/28/13). |
| B 2. 5/31..... | TSRR 2..... | disappeared 7/5/11-11/4/13 (or, is ♂ or ♂ ♀ alive 10/1/14). |
| C 1. 6/30..... | TSRR 3..... | disappeared before 7/5/11. |
| ?♂ C 2. 7/2..... | TS-RR 4..... | alive 10/1/14; is a ♂, or hermaphrodite. |
| D 1. 9/5..... | TS-RR 5..... | probably died early; darker than D 2. |
| D 2. 9/7..... | TS-RR 6..... | probably died early; lighter than D 1. |
- (AA 7)

over, very few embryos. The single surviving bird was a male; that this bird was an intermediate of the white-winged pigeon and the ring-dove in color and general appearance is made clear by its illustration in color in pl. 30.

The sex-ratio and width of cross.—The sex-ratios from the crosses already treated in this chapter are summarized in table 167⁴. The data for the breeding of the pure forms treated in the second part of this chapter are also placed in the table to facilitate a comparison. When the cross was between *families* the progeny were all males; when between *genera* there were 17 males to 9 females; from matings of individuals of the same species there were 53 males to 53 females. Here the evidence is again quite clear that the proportion of male offspring increases as forms more and more widely separated phylogenetically are chosen for parents.

TABLE 163.

σ^{α} *seneg.-alba* \times *risoria* (TS-A-R 3).
 ♀ St. *risoria*; age unknown.

♂ ♀ A 1. 5/9.....	TSARR 1 ¹	color dark.....	dead 1/28/12; hermaphrodite (?).
♂ A 2. 5/11.....	TSARR 2.....	color lighter than A 1; dead	4/26/13.
? ♀ B 1. 6/24.....	TSARR 3.....	pale roseate blond.....	stolen 7/19/12.
♀ B 2. 6/26.....	TSARR 4.....	gray blond.....	dead 2/24/12.
C 1. 8/21.....	TSARR 5.....	dark color, remarkably short, thick beak. ²	
C 2. 8/23.....	TSARR 6.....	color of blond ring, remarkably short, thick beak.	

¹ Had two somewhat flattened sex-glands about 8 by 2 or 2½ mm. Each certainly contained ova, though the anterior part of each gland was testicular in appearance, the few observable small ova being scattered through the posterior part only.—EDITOR.

² The birds from C 1 and C 2 probably died early, before 3 mo. old; but this is not certain.—EDITOR.

TABLE 164.

σ^{α} *senegalensis-alba* (7); 6/1/09; 9/23/14; 64 mo.
 ♀ Sp. *suratensis* (1908).

♀ A 1. 4/12/10; light blond; neck-mark intermediate; dead 6/28/10.
 A 2. 4/14/10; no development.

♂ B. 6/10; light ruddy blond, trifle larger than ring (toward dam); (cold); 11/11/10.
 ♂ C. 7/26; rather dark; neck-mark, etc., toward dam; dead (cold) 11/14/10.

D 1. 9/22; hatched, but died early (cold?).
 D 2. 9/24; hatched, but died early (cold?).

(AA)

TABLE 165.

Pair 1.

σ^{α} *Ect. migratorius* (I A) 7/28-29/96.

♀ *alba-risoria* \times *risoria-alba* (L 2); dead 3/30/98.

A. 1/26/97; broken.	I. 6/5 both developed; one pricked shell, I 2. 6/7 but was accidentally crushed.
B 1. 3/1; hatched.	J 1. 6/28; developed; died just before hatching.
B 2. 3/3; no development.	J 2. 6/30; developed; died just before hatching.
C 1. 3/13; no development.	K. 7/10; no development.
C 2. 3/15; no development.	L. 8/4; hatched; dead 3 to 4 days.
D 1. 3/27; developed; died before hatching.	M 1. 8/13; dead; partly hatched.
♂ D 2. 3/29; hatched.	♂ M 2. 8/15; hatched.
E 1. 4/9; hatched; died few hours.	N. 9/8; no development.
E 2. 4/11; broken.	O 1. 10/6; probably no development.
F 1. 4/18; pricked shell; failed.	O 2. 10/8; probably no development.
♂ F 2. 4/20; hatched.	
♂ G 1. 4/30; hatched.	σ^{α} P 1. 3/24/98; hatched; dead at few days.
♂ G 2. 5/2; hatched; dead 11/30/99.	σ^{α} P 2. 3/26/98; hatched; dead at few days (food ?).
H 1. 5/10; no development.	
♂ H 2. 5/12; hatched.	

* Only first crosses are included in this table. One or two of the crosses which yielded very meager data were omitted for convenience in maintaining the form of the table. The single offspring from a *subfamily* cross (1 ♂ : 0 ♀, table 166, pair 4) is also omitted.



Adult male passenger pigeon, *Ectopistes migratorius*. $\times 0.6$. Hayashi del.



Adult female passenger pigeon, *Ectopistes migratorius*. $\times 0.5$. Hayashi del.

TABLE 165 (*continued*).*Pair 2.*

σ^{α} Ect. migratorius (3 L); 7/12-13/98.
 φ St. risoria.

- A 1. 5/10/03; no development.
A 2. 5/12/03; hatched (with help); dead at 1 day.
B 1. 5/22; probably no development.
B 2. 5/24; broken.
C 1. 7/5; broken.
C 2. 7/7; broken.

Pair 3.

σ^{α} Ect. migratorius.
 φ St. Alba (C 1).

- A 1. 4/4/98; no development.
 σ^{α} A 2. 4/6/98; hatched; dead 2/11/09.
 σ^{α} B 1. 4/15; hatched.
B 2. 4/17; no development.
C 1. 9/10; no development.
C 2. 9/12; no development.

(XS 4)

The length of life of this hybrid—nearly 11 years—is remarkable. Individuals of the mother species usually live 2 to 5 years. *Ectopistes* are long-lived, probably 12 to 20 years. This hybrid, then, was an intermediate in this respect, as well as in many others.—EDITOR.

TABLE 166.

Pair 1.

σ^{α} St. damarensis; age unknown.
 φ risoria-alba hyb.; age (?).

- σ^{α} A 1. 6/15/10.....DM-R 1.....pale blond.....dead 3/6/12.....20½ mo.
 σ^{α} A 2. 6/17/10.....DM-R 2.....pale blond.....dead 2/28/12.....20½ mo.

Pair 2.

Sp. chinensis (Tc).
Sp. suratensis (Tt).

- A 1. 3/14/00; soft shell.
A 2. 3/16/00; soft shell.
B 1. 5/31; hatched; probably died early.
B 2. 6/2; no development.
C 1. 7/4; hatched; dead 10/5/00; cause unknown.
C 2. 7/6; hatched; dead 9/18/00; cause unknown.

(DD 15)

Pair 3.

σ^{α} C. leuconota (1); (1910 or earlier); dead 1/7/15.
 φ C. livia (C-B 6); 6/23/09; alive 1912.

- A 1. 5/?/11; broken.
A 2. 5/?/11; broken.
B 1. about 6/4}
B 2. about 6/4} one hatched (441); died at few weeks.
(O. R.)

Pair 4.

σ^{α} M. leucoptera (1 r); 4/22/99; dull dark, white wings (see text-fig. 8, Vol. I).
 φ alba-ris. \times ris-alba (F 1); 5/1/99; light brown.

- A 1. 4/25/00; imperfect. B 1. 5/5; no development. C 1. 5/29; no development.
A 2. 4/27/00; imperfect. B 2. 5/7; no development. C 2. 5/31; died at once (trampled?).
D 1. 6/20; probably no development. E 1. 8/9; probably no development.
D 2. 6/22; probably no development. E 2. 8/11; probably no development.

σ^{α} H 1. 3/16/01; hatched; color of down like *Melopelia* (see pl. 30); 3/5/03.
H 2. 3/18/01; no development.

- I 1. 4/?; no development. J 1. 4/23; no development. K 1. 5/24; no record.
I 2. 4/?; no development. J 2. 4/25; no development. K 2. 5/26; no record.
L 1. 8/8; did not hatch. M 1. 8/10; probably no development.
L 2. 8/10; hatched; dead at 2 days. M 2. 8/12; probably no development. (A 14.—?)

TABLE 167.—Sex-ratio in family and generic crosses, and in pure-breds.

Family.	σ^{α}	φ	Genera.	σ^{α}	φ	Same species.	Species.				
							σ^{α}	φ	σ^{α}	φ	
σ^{α} Ectopistes	8	0	σ^{α} senegalensis	7	3	σ^{α} risoria	19	21	σ^{α} senegalensis	14	11
φ risoria			φ risoria			φ risoria			φ senegalensis		
σ^{α} Ectopistes	2	0	σ^{α} senegalensis	10	6	σ^{α} chalcoptera	5	7	σ^{α} suratensis	16	14
φ alba			φ alba			φ chalcoptera			φ suratensis		
Total....	10	0	Total.....	17	9				Total.....	53	53

BREEDING DATA UPON PURE-BRED PIGEONS AND DOVES.

Some data dealing with various features of the breeding of several species of doves and pigeons are here of interest, not only because they permit comparisons between the results from one and the same species when pure-bred and when crossed, but because they supply additional information on the relation of the order of eggs in the clutch to sex, and on some features of the periods of incubation and egg-production.

Spilopelia suratensis.—In tables 168 and 169 the results of two long series of matings of Surate turtle-doves (see pl. 24) are given. Both records show almost uniformly "weak germs" from the first and the last eggs of the season; the two pairs were (unequally) overworked. In general the term of life of the offspring is longer in those birds hatched from the eggs of spring and early summer. The pair recorded in table 169 was much "overworked" in comparison with the previous mating, and it will be noted that the much-overworked series is clearly the series of lowest fertility and of shortest average term of life in the offspring. In this much-overworked series all of the eggs of no two successive clutches were able to hatch, except in the early part of the season; here (April 22 to June 18), however, five successive clutches hatched without a failure.

Stigmatopelia senegalensis.—The records for this species are summarized in table 170. In this species there is indicated a decided tendency to produce males from the first egg of the clutch and females from the second. There were 11 males from the first and 2 from the second egg. There were 9 females from second eggs and only 2 females from first eggs.⁵

⁵ The breeding of *Chamaepelia talpicoti* (table 172) and of *Geotrygon* sp. (table 173) furnish little or no data on sex and are of interest only from the standpoint of fertility; 2 pairs (of *talpicoti*) showed all eggs hatching until late fall; the hatches at this season gave very weak and short-lived offspring.—EDITOR.

EXPLANATION OF PLATE 30.

- A. Adult male hybrid (H 1) from a white-winged pigeon and a ring-dove hybrid. One-half natural size. Hayashi del., 1901. Hatched April 1, 1901; dead March 5, 1903.

Sire: *Melopelia leucoptera*. Hatched 4/22/01. A bird of dull dark color with the outer flights of wings white. Dam: *St. alba-risoria* × *risoria-alba* × *alba*; a bird of light-brown color.

- B. Adult male passenger-pigeon × ring-dove hybrid. One-half natural size. Hayashi del.

The wing feathers and markings in this hybrid are (June 18, 1905) as follows:

Tertiaries, 7: Two inner covered by scapulars. Third exposed, has an obscure, half-washed-out chequer on upper web; this about 15 mm. in length; its distal boundary about 14 mm. from tip of feather. Fourth similarly marked. Fifth has same mark vanishing. Sixth exposed part is darker than fifth, but there is no mark; i.e. the "brown" of the inner feathers gradually diminishes and becomes more gray and a little darker. Seventh slightly less brown and a little darker.

Secondaries, 6: Eighth to thirteenth have an elongated chequer on lower web, beginning with a length of about 24 mm. and extending to within 3 or 4 mm. of tip. The spot grows stronger and longer, becoming about 40 mm., and ending obscurely about 5 mm. from tip on outer secondary, namely the thirteenth feather (including tertials).

Primaries, 10: Fourteenth to twenty-third (counting from inner tertial); a chequer seen on three inner primaries, vanishing on the sixteenth feather (third primary).

Primary coverts, 10: Second to seventh marked with a short chequer on the lower (outer) web, the mark running to the very tip of the feather. In the passenger-pigeon these feathers are black, hence chequers arise by reducing the basal portions to gray.

Scapulars: The inner, second longer scapular has a chequer about 20 mm. long on inner half of inner web and reaches to within 12 mm. of the tip of the feather.

In one hybrid of this derivation these marks were somewhat stronger. They correspond to conspicuous marks in the passenger-pigeon and in the mourning-dove.



A



B

A. Adult male hybrid (H1) from a white-winged pigeon and a ring-dove hybrid. $\times 0.5$.
Hayashi del., 1901. Hatched Apr. 1, 1901; dead Mar. 5, 1903.
B. Adult male passenger-pigeon \times ring-dove hybrid. $\times 0.5$. Hayashi del.

Phaps chalcoptera.—A small amount of data for bronze-wing and crested pigeons is of interest in connection with the question of the sex produced by the first and second eggs of the clutch. Both these Australian species lay 2 eggs in a clutch. In the bronze-wing the slender data would indicate (table 171) a decided tendency for the first egg to produce a male and for the second egg to produce a female. It will be noted that the apparent exceptions to be seen in pair 2 (*A 1* and *B 1*) are nevertheless clutches in which the second egg seemed *weaker* than the first; one of these failed to develop and the other yielded a bird of unknown sex that died when a week old.

Fewer still are the data for the crested pigeon (*Ocyphaps lophotes*). The sex of the birds from the 2 eggs of the same clutch was learned in 3 cases; only one sex arose from each of these clutches. (Sh 18/13)

TABLE 168.

♂ Sp. suratensis; imported about 5/1/97.

♀ Sp. suratensis; imported about 5/1/97.

♀ A 1. 5/31/97; killed; 10/16/97; deformed legs. A 2. 6/2/97; developed but died before hatching.	B. 6/29; lost (trip).
♀ C 1. 8/17.....	10/1/98.....
♂ C 2. 8/19.....	9/3/98.....
D. 9/26; egg lost.	
E 1. 10/14.....	9/?/98.....
♀ E 2. 10/16.....	10/2/98.....
F 1. 11/18; deserted; nearly fully developed embryo. F 2. 11/20; deserted; nearly fully developed embryo.	
G 1. 12/6; developed, but young unable to prick shell. G 2. 12/8; developed, but young unable to prick shell.	H 1. 12/28; developed, pricked shell, then died. H 2. 12/30; developed, died without prickling shell. (Birds moved, to stop laying).
I 1. 3/23/98; deserted. I 2. 3/25/98; deserted, thin shell.	K. 4/10; thin shell; broken.
J 1. 4/1} J 2. 4/3} one broken; one some development.	L 1. 5/2; developed near to hatching. L 2. 5/4; no development; thin shell.
♂ M 1. 6/3.....	10/17/98.....
♂ M 2. 6/5.....	10/14/98.....
N 1. 7/2; accident; broken. N 2. 7/4.....	10/23/98.....
♂ O 1. 7/13.....	11/7/98.....
♀ O 2. 7/15.....	10/13/98.....
♂ P 1. 8/5.....	10/30/98.....
♀ P 2. 8/7.....	10/24/98.....
♀ Q 1. 9/14..... Q 2. 9/16; hatched; apparently died early.	10/26/98.....
♀ R 1. 10/23..... ♀ R 2. 10/25.....	11/19/98..... 11/23/98.....
♂ A 1. 4/19/99..... A 2. 4/21/99; dwarf egg 25 by 19 mm.; no development.	12/1/99.....
♀ B 1. 4/29..... B 2. 5/1; hatched; alive July 1901.	alive July 1901.....
♀ C 1. 5/28.....	12/14/99.....
♂ C 2. 5/30.....	12/25/99.....
♂ D 1. 6/26.....	11/26/99.....
♀ D 2. 6/28.....	12/29/99.....
♀ E 1. 7/26..... E 2. 7/28; apparently did not hatch.	11/27/99.....

(C 7/4)

Streptopelia risoria.—Attention may first be given to features of the record (tables 174 to 176) other than sex and fertility. In these tables⁶ data are given for the time consumed between sets or clutches of eggs in the blond ring-doves. This period is variable; but it is clear that in the season which was later found to be that of "weak germs" there is probably no natural tendency to shorten the period. Such a shortening of the period would of course tend toward still further "overwork," which has been found to lead to the weakening of the germ. Rather do the data indicate that in this late autumn and winter period, when the germs are weakest, the birds are reproductively less active; and this corresponds thoroughly with the common experience with doves and pigeons generally.⁷

The interval between the laying of the 2 eggs of the clutch and the period of incubation were in many cases very accurately determined. The period for the former is nearly 40 hours; for the latter the period is variable and is different for the 2 eggs of the clutch, the first egg requiring usually 12 to 24 hours longer than the second. The author has pointed out, however, that the first egg is usually not incubated perfectly during the first 12 to 24 hours; the female sits or stands but

TABLE 169.

♂ Sp. suratensis (1); from dealer (9/30/07); (said to have come from Borneo); alive 1915.

♀ Sp. suratensis (1); from dealer (9/30/07); dead 1/12/09; 2+ yr.

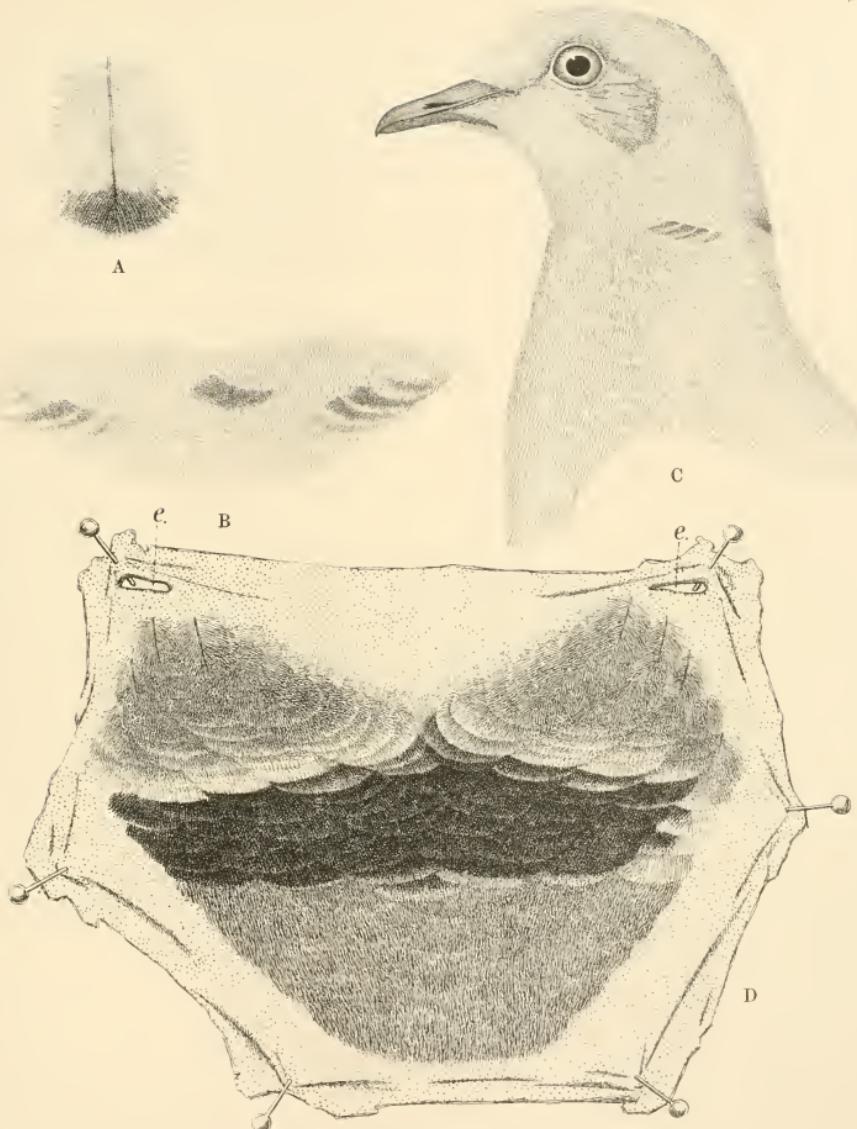
A 1. 10/14/07	one hatched, neglected; other failed.	P 1. 6/30; deserted.
A 2. 10/16/07		P 2. 7/2; deserted.
B 1. 11/29; hatched; dead, cold.		Q 1. 7/9; no record.
B 2. 12/1; did not hatch.		Q 2. 7/11; no record.
C 1. 2/25/08; thin shell; no development.		R 1. 7/19.....21.....probably died early.
C 2. 2/27; thin shell; no development.		R 2. 7/21.....22.....probably died early.
D 1. 3/7; hatched; dead at 2 days.		S 1. 7/27; did not hatch.
D 2. 3/9; fully developed; failed.		S 2. 7/29.....23.....probably died very early.
E 1. 3/18; full term embryo; cold.		T 1. 8/4.....24.....dead 9/14/08.
E 2. 3/20; full term embryo; cold.		♂ T 2. 8/6.....25.....dead 9/10/08.
F 1. 3/29; no record.		U 1. 8/14; developed; deserted.
F 2. 3/31; no record.		U 2. 8/16; developed; deserted.
G 1. 4/5.....10.....hatched.		V 1. 8/22.....26.....hatched.
G 2. 4/7; dead at 3 days.		♂ V 2. 8/24.....27.....hatched; dead 9/19/14.
H 1. 4/13; failed.		W 1. 8/31; hatched; died, neglect.
H 2. 4/15; failed.		W 2. 9/2; not hatched.
I 1. 4/22.....11.....hatched.		X 1. 9/7.....28.....hatched.
I 2. 4/24; hatched; dead at 6 days.		X 2. 9/9; no development.
♂ J. 5/2.....12.....hatched; dead 8/5/08.		Y 1. 9/15; failed.
♂ K 1. 5/12.....13.....hatched; dead 10/8/08.		Y 2. 9/17; failed.
K 2. 5/14.....14.....hatched.		Z 1. 10/3; AA 1. 10/11; BB 1. 10/20, not incubated.
♂ L 1. 5/25.....15.....hatched; dead 9/21/08.		Z 2. 10/5; AA 2. 10/13; BB 2. 10/22, not incubated.
♂ L 2. 5/27.....16.....hatched; dead 9/12/08.		CC 1. 11/9.....29.....hatched; died 2/9/09.
♂ M 1. 6/2.....17.....hatched; dead 9/5/08.		CC 2. 11/11.....30.....hatched; died 2/10/09.
♀ M 2. 6/4.....18.....hatched; dead 9/14/08.		DD 1. 11/19; no development; neglect (?).
N 1. 6/10; failed.		DD 2. 11/21; no development; neglect (?).
N 2. 6/12; failed.		EE 1. 11/28; hatched; not fed.
♀ O 1. 6/19.....19.....hatched; dead 9/19/08.		EE 2. 11/30; fully developed embryo.
♂ O 2. 6/21.....20.....hatched; dead 9/25/08.		Parents removed 12/1/08.

(Sh 6/13)

NOTE.—The second egg was less fertile, or produced a bird clearly less strong, in 7 cases; the first egg showed the same in 1 case.

⁶ These three tables were prepared in their complete and present form by the author.

⁷ "November 6, 1908. The pigeons have been doing less and less since August and are now pretty near the lowest ebb. I have only 2 pairs of common pigeons (out of 10 pairs) with eggs and 2 with young." (R 16)



Neck-mark in *Streptopelia risoria*.

- A. The separate feather is the darkest one from the neck-mark (left-side). $\times 3$.
- B. Juvenile ring-dove; same as figure C. Hayashi del., July 1902.
- C. Juvenile ring-dove; 6 weeks old. $\times 1.2$. Hayashi del., July 1902. For comparison of juvenile neck-mark in other doves. The darker feathers of mark begin here in *two loci*, lateral and posterior.
- D. Adult female ring-dove. $\times 2$. April 25, 1902. The skin was split up in middle of neck (in front) and spread out to show entire ring; outside feathers pulled out. Five rows of feathers in each half (right to left) of ring, but 3 rows make most of the ring. At extreme upper and lower margins of the ring are feathers with lighter tips.

lightly over it at this time. Other items of interest are found in the tables, and these may be consulted by those who are interested in these topics.

These ring-doves are so highly fertile that but few instances of "no development" or "failed to hatch" are to be found in the records. There are a few such cases, however, and they are associated with the following months: December (table 174), January (table 175), August (table 176), June (one case), and November (three cases, table 177).

Sex and egg of clutch.—It has previously been noted (table 167) that the above group of blond rings threw 19 males and 21 females. It may now be observed that these pure rings produce males more often from the first egg of the clutch and females more often from the second. The cases recorded in these tables furnish 8 instances in which the two sexes were produced by the same clutch. In 6 of these the first egg gave rise to the male and the second egg yielded a female; in 2 cases this order was reversed.

TABLE 170.—*Relation of sex to first and second egg of clutch in pure Stig. senegalensis.*

Parents.	Sex and clutch.	Date.	Dead.	Length of life.	Parents.	Sex and clutch.	Date.	Dead.	Length of life.
				yr. mo.					yr. mo.
Pair 1	{ B 1 { ♀ B 2	4/20/08 4/22/08	11/19/09. 12/ 3/08.	1 7 7 1	Pair 3	{ ♂ J (No second egg.	5/21/09	8/20/09.	3
	{ ♂ D 1 { D 2	7/23/08 7/25/08	Alive 1914. 8/13/08.	6+ 1/2		{ ♂ K 1 K 2	7/ 5/09 7/ 7/09	8/26/09.	
Pair 2	{ A 1 { ♀ A 2	4/26/08 4/28/08	(?) alive 1910. 9/20/08	? 2+ 5	Pair 4	{ ♂ L 1 (♀ L 2	7/30/09 8/ 1/09	11/27/09 (care ?). 11/27/09 (care ?)	4 4
	{ ♀ C 1 C 2	6/30/08 7/ 2/08	11/24/08.	5 ? 5+		{ ♂ B 1 ♀ B 2	9/ 1/10 9/ 3/10	1/25/12. Alive 1914.	1 4+
Pair 3	{ ♀ F 1 F 2	10/19/08 10/21/08	2/ 8/09. 11/28/08 (cold).	3 1/2	Pair 5	{ ♂ A 1 A 2	3/30/10 4/ 1/10	11/26/13. Died early (cold).	3 8
	{ ♂ A 1 A 2	5/ 5/08 5/ 7/08	10/19/08. (?) alive 1910.	5 1/2 2+		{ ♂ C 1 C 2	6/ 3/10 6/ 5/10	8/21/13 escaped.	3+
..	{ ♂ B 1 B 2	5/14/08 5/16/08	8/ 9/08.	3 ? 3+	Pair 6	{ A 1 ♀ A 2	4/ 1/10 4/ 3/10	..... 10/10/10 (food ?)	? 7+ 6+
	{ ♂ D 1 D 2	7/ 3/08 7/ 5/08	Alive 1910. 11/19/09.	2+ 1 4 1/2		{ C 1 ♀ C 2	6/15/10 6/17/10	2/ 8/13.	2 8
..	{ F 1 ♂ F 2	9/ 2/08 9/ 4/08	? 2+ Alive 1910.	? 2+ 2+	Pair 7	{ D 1 ♀ D 2	7/16/10 7/18/10	3/16/12.	1 8
	{ G 1 ♀ G 2	10/ 9/08 10/11/08	? 5+ 3/ 5/09.	? 5+ 5		{ ♂ E 1 ♂ E 2	9/11/10 9/13/10	11/21/11. 1/29/12.	1 4 1/2
..	{ ♂ I 1 I 2	3/11/09 3/13/09	7/30/09. Unhatched.	4 1/2 0	Pair 7	{ C 1 ♀ C 2	7/30/10 8/ 1/10	11/19/10 (cold).	3+
Total..	{ 12 ♂'s from first egg; 2 ♀'s from first egg. { 2 ♂'s from second egg; 9 ♀'s from second egg.								

TABLE 171.

♂ Phaps chalcoptera; from dealer 10/30/03.

♀ Phaps chalcoptera; from dealer 10/30/03.

Pair 1.

♂ A 1. 6/11/05.	D 1. 9/29.
♀ A 2. 6/13/05.	♀ D 2. 10/1.
♂ B 1. 7/13.	♂ I 1. 5/3/06.
♀ B 2. 7/15.	I 2. 5/5/06.
♂ C 1. 7/25.	
♀ C 2. 7/27.	

Pair 2.

♀ A 1. 9/8/05; hatched.	♂ C 1. 1/3/06.
♀ A 2. 9/10/05; no development.	♀ C 2. 1/5/06.
♀ B 1. 10/1; lived several months.	D 1; no record.
B 2. 10/3; dead at week.	D 2; no record.

(RR 33)

We may here list the sex-relation of the 2 eggs of the clutch as it is displayed in the records of the several matings and species dealt with in the present chapter.⁸ If A be allowed to represent "pairs of eggs" in which the first egg produced a male and the second a female, and B the reverse, we then may read as follows:

	A	B		A	B		A	B		A	B
♂ senegalensis . . .	2	1 ¹	senegalensis-alba	2	0	senegalensis . . .	1	1 ¹	chinensis . . .	1	0
♀ alba			risoria			risoria			suratensis		
♂ senegalensis . . .	2	0	risoria . . .	6	2	chalcoptera . . .	4	0	suratensis . . .	4	3
♀ senegalensis			risoria			chalcoptera			suratensis		
	4	1		8	2		5	1		5	3

¹ These birds hatched from the first or last clutch of the season.

It thus appears that from all of these "pure-bred" females, representing several different species, the first eggs of the clutch more often produce males and the second more often females. This has been noted in previous chapters to hold for the species considered there. A further word concerning this general situation should doubtless be added.

From the time of Aristotle to the immediate present there have appeared statements concerning a predominance or a lack of predominance of males from the first egg and of females from the second egg of the pigeon's clutch. It is quite unnecessary to discuss at length any of these divergent reports. They have all been based on a general statistical method, which is a wholly inadequate and useless method for a study of the problem. It is clear from all that has preceded in this volume that the method that would be valuable must be an *analytical* one. The author has laid the foundation, and fashioned much of the superstructure, of a proper analytical study of this point. He has shown that from the periods of the production of

TABLE 172.

♂ Cham. talpicoti.	♂ Ch. talpicoti; (imported 1909).
♀ Cham. talpicoti.	♀ Ch. talpicoti; (imported 1909).
♂ A 1. hatched . . . 1 . . . 6/1/08 . . . dead 12/26/11.	♂ A 1. hatched . . . 6 . . . 6/25/09; possibly alive 1/1/15.
A 2. hatched . . . 2 . . . 6/1/08.	A 2. hatched . . . 7 . . . 6/25/09; shade darker than A 1.
B. hatched . . . 3 . . . 7/10.	♂ Ch. talpicoti (6); hatched 6/25/09.
C 1. hatched . . . 4 . . . 8/5.	♀ Ch. talpicoti (O).
C 2. hatched . . . 5 . . . 8/6.	
D 1. 8/14; no development.	A 1. hatched . . . 8 . . . June (?) 1910.
D 2. 8/16; no development.	A 2. hatched . . . 9 . . . June (this bird or sire (6); alive 1/1/15).
E 1. hatched; 9/28; died very soon.	B 1. hatched . . . 10 . . . July (?).
E 2. hatched; 9/28; died very soon.	B 2. hatched . . . 11 . . . July (?).
	C 1. hatched . . . 12 . . . August.
	C 2. hatched . . . 13 . . . August.
	D. 1 8/31 } one hatched, died at one week; one, no develop- D. 2 9/2 } ment. (Sh 20/13)

TABLE 173.

♂ Geotrygon sp.	E 1. 8/20/03; broken.
♀ Geotrygon sp.	E 2. 8/22/03; broken.
A 1. 7/14/02; hatched.	C 1. 9/25; no development.
A 2. 7/16/02; hatched.	C 2. 9/27; hatched.
B 1. 8/12; hatched.	D 1. 10/11; hatched.
B 2. 8/14; hatched.	D 2. 10/13; hatched.
	F 1. 10/19; hatched.
	F 2. 10/21; hatched. (Sh 23/13)

⁸ Only matings in which the female is "pure bred" (not hybrid) are tabulated. The proportion of males and females from the 2 eggs of the clutch in other species, or in matings of some of the above species with still other forms, has been considered in the several previous chapters; i.e., in connection with the fully tabulated records.—EDITOR.

the "strongest germs" an undue proportion of "pairs" of eggs produce males and that from the opposite period there arise undue numbers of pairs of eggs that produce females. To lump these altogether and to count the number of males arising from first and females from second eggs is plainly to cover up or lose the significance of the intervening pairs of eggs which bear the significant data. Again, many matings, because of exceptional strength or of weakness, will yield a considerable total predominance of males or of females, and the statistical method lumps all without thought or care of the cancellations and unsatisfied cancels involved; all of which as easily contributes to a "smoothing" of the results, as it does to a "smothering" of them.⁹

But it has been demonstrated by the author that not only is the *method* previously employed gravely at fault, but that the *material* used, in nearly all of those cases where the worker has thought it worth while to mention what form was studied, has been wholly unsuitable for leading to a decision; that is to say, the "pigeons" used were in most cases one or another of the 150 "mongrels" collectively known as domestic pigeons. One of the clearest points of our present knowledge of the relation of sex to egg of clutch is that the normal relations of these are *lost immediately upon hybridization—i.e., in passing from the pure state of the species*. The countless degradations and crossings suffered by the various "domesticated breeds" of pigeons since their existence as a pure wild species is, therefore, a sufficient index of the unsuitability of this material in a study of this subject.

Among all of the published statements to date, only in that of Cuénnot does one find even a suggestion which points in the direction of recent findings and toward a reconciliation or understanding of the discordant data hitherto reported. Cuénnot¹⁰ suggested that sex-production from the pigeons' clutches *may vary in the different races and subraces of pigeons*. This point, if applied to some domestic races, as compared with some pure wild species, would certainly be wholly true; possibly it is true also among the races and subraces of which he speaks.

It now seems certain that in many wild species of pigeons the rule is for the first egg of the clutch to produce a male and for the second to produce a female. It also seems probable that this order is normally reversed in some other wild species.¹¹ It is probable, moreover, that included in some species which normally produce a predominance of males from first and of females from second eggs there are exceptional individuals which quite regularly present the sexes in the reverse or in an irregular order. But these subsidiary points, together with the frequency of the reversals of order of the sexes in the "very first clutch" of the season (possibly also in the very last clutch under certain conditions) have not been adequately dealt with by the author, nor are they satisfactorily decided by his data; they must therefore await further and future analysis. These particular topics have been under investigation by the editor during the past 4 years. A large amount of data, obtained from several different lines of study, is still being accumulated and will probably not be long delayed in publication.

⁹ "Statistical results, giving the averages of many cases, give the average of chances. We want to know what happens under normal or prescribed conditions, with chance eliminated to the utmost. Statistics lead away from the careful study of the individual cases, on the assumption that such cases can not be understood except in the mass, where individuals are lost. It is evident that the result in *any case* depends upon *all* of the *particulars*, and the more thoroughly these are understood the better the result can be understood." (W 8.)

¹⁰ Bul. Sci. France et Belg., vol. 32 (5th ser., vol. 1), 1899.

¹¹ Possibly the purity of these species should be questioned.

INHERITANCE, FERTILITY, AND SEX IN PIGEONS.

TABLE 174-175.—Record of family A.

[♂] St. risoria (A) from dealer late 1891; alive 10/1/97; 3+ yr.
[♀] St. risoria (A) from dealer late 1884; dead 10/10/97; 3+ yr.

Clutch.	Date of laying.	Time between eggs.	Hatched.	Inetration.	Size.	Wt. in grams.	Age at laying.	Sex.	Remarks.
B	Apr. 21, 1885.....	.....	May 6, 1885.....	15 days ².....	.....	.....	10 mo. 1 da.	♀	Sex evident at 10 weeks old.
C 1	May 26.....	.....	June 12, or earlier.....	14-15 days.....	.....	.....	6 mo. 5 da.	♂	Size indicated ♂ was from C 1.
C 2	May 28.....	.....	June 12, or earlier.....	14 days (?)	.....	.....	6 mo. 11 da.	♀	Size indicated ♂ was from C 1.
D 1	July 1, 4 to 5 P.M.....	1 da. 15 to 20 hr.	July 15; night.....	14 days.....	.....	.....	6 mo. 11 da.	♀	"Instinct supposed male." of pair D turns out a female. (in Chapter III, Vol. III.—Ed.).
D 2	July 3, 7 th 62 min. a.m.	1 da. 15 to 20 hr.	July 17, 9 to 12 a.m.	14 days ²	2d smaller than 1st	.....	6 mo. 18 da.	♀	No eggs laid in first nest. (Feb. 8, 1886).
E 1	Aug. 1, 2 to 6 p.m.	1 da. 14 to 23 hr.	Aug. 16, 9 a.m. to 1 p.m.	14 da. 15 to 19 hr.	2d larger than 1st	.....	6 mo. 16 da.	♀	Unmated.
E 2	Aug. 3, 8 to 1 p.m. ....	.....	Aug. 16-17, night.....	14-15 days.....	.....	.....	4 mo. 20 da.	♂	[Eggs laid on railway journey (Boston to Chicago); both young of light color.
F	Sep. 14, 2 to 6 p.m. ....	.....	Sept. 29.....	.....	.....	.....	29.7 mo. 20.5	♀	Dissected May 4, 1896. This second egg remarkably small!
G 1	Oct. 25, 1 st 30 th to 1 st 30 th p.m.	Nearly 2 da.	Nov. 7, 1 st 30 th to 2 da.m.	14 da. 22 hr. ².....	.....	.....	.....	♂	Both young of very light color.
G 2	Oct. 26, 3 to 6 p.m.	1 da. 15 to 19 hr.	Nov. 8, 29 pm. to 6 a.m.	14 da. 12 hr. ².....	.....	.....	.....	♀	.....
H 1	Dec. 28, 8 to 10 a.m. ....	.....	Jan. 10-11, 1896, night.....	15 days ²	29.81 y 23	8.495	.....	♀	.....
H 2	Dec. 28, 8 to 10 a.m. ....	.....	Tailed to develop.....	.....	29.7 mo. 20.5	6.235	.....	♂	.....
I 1	Feb. 4, 1896, 4 to 6 p.m.	1 da. 16 to 18 hr.	Feb. 19, 1 st 30 th to 2 da.p.m.	14 da. 20 to 22 hr.	29.31 y 23	8.321	.....	♂	.....
I 2	Feb. 12, 4 to 6 p.m.	1 da. 16 to 18 hr.	Feb. 19, 10 p.m. to 6 a.m.	14 da. 4 hr. ²	31.01 y 23	8.685	.....	♀	.....
J 1	Mar. 12, 4 to 6 p.m.	1 da. 15 to 16 hr.	Mar. 28, 12 to 6 a.m.	15 da. 8 to 10 hr.	29.25 by 23	8.315	.....	♂	.....
J 2	Mar. 14, 8 to 9 a.m.	1 da. 15 to 16 hr.	Mar. 28, 12 to 6 a.m.	14 da. 4 hr. ²	30.01 y 23	8.525	.....	♂	.....
K 1	Apr. 15, 4 to 5 p.m.	(to 16 hr. 38 m.)....	Apr. 30, 5 to 7 a.m.	14 da. 12 to 15 hr.	29.01 y 23	8.884	.....	♂	Dissected May 7.
K 2	Apr. 17, 8 th 38 th a.m.	(to 16 hr. 38 m.)....	Opened May 1, 3 p.m.	14 da. 12 hr. ²	30.01 y 23	8.525	.....	♂	Dissected May 4.
L 1	May 13, 3 rd to 3 rd 45 th p.m.	1 da. 15 to 16 hr.	May 27-29, morning(?)	14 da. 12 hr. ²	30.01 y 23	8.587	.....	♀	.....
L 2	May 15, 8 to 8 th 30 th a.m.	1 da. 15 to 16 hr.	May 27-29, morning(?)	14 da. 4 hr. ²	30.01 y 23	8.587	.....	♀	.....
M 1	June 18, 4 th 46 th a.m.	1 da. 15 to 16 hr.	July 3, after 5 a.m.	15 da. 4 to 16 hr.	29.51 y 23.5	8.672	.....	♂	.....
M 2	June 20, 8 to 8 th 45 th a.m.	1 da. 15 to 16 hr.	July 4-5, 8 p.m.-to 8 a.m.	14 da. 12 to 24 hr.	21.0 mo. 23.5	9.557	.....	♀	.....
N 1	July 25, 4 th 35 th p.m.	1 da. 15 hr. 1 m.	Aug. 9, 5 to 6 a.m.	14 da. 12 to 13 hr.	30.01 y 23.5	9.022	.....	♂	Both dissected.
N 2	July 27, 7 th 36 th a.m.	1 da. 15 hr. 1 m.	Aug. 10, 12 th -30 th p.m.	14 da. 5 hr.	31.51 y 23.5	9.325	.....	♀	.....
O	Aug. 31.....	.....	Sept. 16, 1896.....	Usual time.....	.....	.....	.....	♀	No 2d egg laid.
P 1	Oct. 15.....	1 da. 15 to 16 hrs.	Oct. 31.....	15 da. 20 hr. ....	.....	.....	.....	♂	Dead 12/25/96.
P 2	Oct. 17.....	1 da. 15 to 16 hrs.	Oct. 31.....	14 da. 5 to 6 hr. ....	.....	.....	.....	♀	Dead 12/4/96.
Q 1	Dec. 21.....	Longer than usual.	Jan. 6, 1897.....	15 da. 8 to 12 hr. ....	.....	.....	.....	♀	.....
Q 2	Dec. 23.....	Longer than usual.	Jan. 6, 1897.....	14 da. 3 hr. 40 m. ....	.....	.....	.....	♂	Killed 2, 15/97.
R 1	Jan. 28, 1897.....	1 da. 16 hrs. 41 m.	Feb. 13.....	14 da. 3 to 4 hrs. ....	.....	.....	.....	♀	No development.
S 1	Mar. 4.....	1 da. 16 hrs. 44 m.	Not incubated.....	.....	.....	.....	.....	♀	No later record.
S 2	Mar. 6.....	1 da. 15 hrs. 51 m.	Not incubated.....	.....	.....	.....	.....	♂	Parents given other eggs till 3/21.
T 1	Mar. 27.....	1 da. 15 hrs. 51 m.	23 days	.....	.....	.....	.....	♀	7 day embryo killed.
T 2	Mar. 29.....	1 da. 15 hrs. 51 m.	23 days	.....	.....	.....	.....	♂	7 day embryo killed. (C 7/16)

¹ This also probably the first egg in life for this female.

² Indicates nearly the exact time.

TABLE 174-175 (continued).—Record of family A.

♂ St. risoria (A) from dealer late 1894; alive 10/1/97; 3+ yr.
 ♀ St. risoria (A) from dealer late 1894; dead 10/10/97; 3+ yr.

Clutch.	Date of laying.	Time between eggs.	Since previous set (in days.)	Hatched.	Incubation.	Remarks.
U 1	Apr. 27.....	1 da. 16 hrs. 7 m.	31 days	Not incubated		
U 2	Apr. 29.....			Not incubated		
V 1	June 2.....	1 da. 14 to 15 hrs.	36 days	Not incubated.		
V 2	June 4.....			Not incubated.		
W 1	June 23.....		21 days			Egg broken.
W 2	June 25.....					Egg broken.
X 1	July 20.....		27 days	Aug. 4.....	14 da. 12 hrs. ¹	Killed at few days.
X 2	July 22.....					No record.
Y	Aug. 14.....		25 days	Not incubated.		No second egg.
Z 1	Sept. 14.....		31 days	Sept. 29.....	Usual time.	These eggs incubated during rail-way journey. (C 7/16)
Z 2	Sept. 16.....			Sept. 29.....		

¹ Indicates nearly the exact time.

TABLE 177.

♂ St. risoria (C); hatched 6/12/95; brother; 8/?/00; 5 yr. 2 mo.

♀ St. risoria (C); hatched 6/12/95; sister; lived longer than mate (above).

Birds were 6 months and 5 days old when first eggs were laid.

♂ A 1. 12/17/95..... 8.335 g..... weak (poor feeding); killed 3/25/96.

♂ A 2. 12/19/95..... 8.118 g..... weak (poor feeding); killed 3/25/96.

B 1. 1/31/96; thin shell; broken.

B 2. No record.

♂ C 1. 2/8..... 7.984 g..... killed 5/11/96.

♂ C 2. 2/10..... 8.241 g..... killed 5/4/96.

♀ D 1. 3/13..... 8.630 g..... hatched.

♂ D 2. 3/15..... 9.225 g..... hatched.

♀ E 1. 4/13..... 8.489 g..... hatched.

♀ E 2. 4/15..... 8.838 g..... hatched.

♂ F 1. 5/12..... 8.720 g..... killed 6/25/96.

♂ F 2. 5/14..... 9.256 g..... killed 6/2/96.

G 1. 6/12..... 8.972 g..... failed to hatch.

♀ G 2. 6/14..... 9.365 g..... killed 9/2/96.

H 1. 7/10..... 8.692 g..... embryo killed.

H 2. 7/12..... 9.520 g..... embryo killed.

I 1. 7/27..... 8.425 g..... not incubated.

I 2. 7/29..... 9.120 g..... not incubated.

J. 11/2; some development.

K 1. 11/26; some development.

K 2. 11/28; fully developed; pipped; failed to hatch.

L 1. 12/23; hatched.

L 2. 12/25; hatched.

(C 7/17)

These birds were kept mated and laid numerous eggs during 1897 (22 eggs), 1898 (16 eggs), 1899 (18 eggs), and 1900 (7 eggs). The male died 8/?/1900. Few of these eggs were incubated—this pair being used to nest the eggs of other birds. Nevertheless 6 eggs were hatched in 1897, 6 in 1898, and 8 in 1899. The length of life of all these young is unknown.—EDITOR.

TABLE 176.—Record of family G.

♂ St. risoria (G); 7/25/99.

♀ St. risoria (G); 10/23/95 to 7/25/04; age 4 mos. 20 da. at time of first laying.

Clutch.	Laid.	Time between eggs.	Since previous set in (days).	Hatched.	Incubation.	Weight of egg.	Remarks.
B	Mar. 27, 1896					5.900	One egg only; thin shell.
C	Apr. 11		15				One only; laid from perch.
D	Apr. 18		7			6.560	One only; thin shell.
E	Apr. 26		8				One; good shell. ¹
♀ F 1	May 4	1 da. 15 to 16 hrs.	8	May 19, 4 ^b 15 ^m p.m.	15 days	7.462	Killed Jan. 27, 1898.
♂ F 2	May 6			May 20, 12 ^b 50 ^m p.m.	14 da. 4 to 5 hrs.	8.285	Died July 17, 1897.
♂ G	June 17		44		14 da. 15 to 20 hrs.	7.745	Killed at hatching.
H 1	July 14					8.505	Killed July 22.
H 2	July 16	Usual time.	27			8.805	Killed July 22.
I 1	Aug. 21			Sept. 5, before 6.	14 da. 13 hrs.		
I 2	Aug. 23	1 da. 14 hrs. 48 m.	38	Sept. 6, before 7.	13 da. 22 to 23 hrs.		
J 1	Sept. 25						Eggs lost.
J 2	Sept. 27	Usual time.	35				
K 1	Nov. 1						Dead (food), Nov. 21.
K 2	Nov. 3	1 da. 15 to 16 hrs.	37	Nov. 16, 1 p.m.	14 da. 20 hrs.		Dead (food), Nov. 23.
L	Dec. 23	On nest but failed to lay.		Nov. 17, 1 to 2 p.m.			
M 1	Jan. 1, 1897						Dead Jan. 17, 1897.
M 2	Jan. 3	1 da. 18 hrs. 2 m.	9 or 61	Jan. 16, 3 ^b 20 ^m p.m.	15 days.		
N 1	Jan. 14			Jan. 17, 12 (?) m.	14 da. 3 hrs. (?)		
N 2	Jan. 16		13				Broken.
O 1	Jan. 24						Dead Feb. 14, 1897.
O 2	Jan. 26			Feb. 8, early a.m.			
P 1	Mar. 6			Feb. 9, 2 p.m.	14 da. 4 to 6 hrs.		
P 2	Mar. 8	1 da. 16 hrs. 42 m.	41	Mar. 21, early a.m.	14 da. 12 hrs. (?)		
Q 1	Apr. 12			Mar. 22, 2 p.m.	14 da. 41 ⁴ hrs.		
Q 2	Apr. 14	1 da. 16 hrs. 39 m.	37				
R 1	Apr. 19			No record.			
R 2	Apr. 21	1 da. 15 hrs. 44 m.	7				
S 1	May 20			No record.			
S 2	May 22	1 da. 15 hrs. (?)	31	No record.			
T 1	June 12			June 27, 5 to 6 a.m.	14 da. 12 to 13 hrs.		
T 2	June 14	1 da. 15 to 16 hrs.	23	June 28, p.m.	14 da. 4 to 6 hrs.		
U 1	July 19			Aug. 3	No record.		
U 2	July 21	(?)	37	Aug. 3	No record..		
W 1	Aug. 24			Did not hatch.			
W 2	Aug. 26	1 da. 14 to 15 hrs.	36	Sept. 9, a.m.	14 da. (?) h.		
X 1	Oct. 7			Removed Oct. 16.			
X 2	Oct. 9		44				
Y 1	Dec. 14						
Y 2	Dec. 17		68	Jan. 31 to Feb. 1.			
Z 1	Feb. 19, 1898			67	Mar. 6	14 da. 19 to 21 hrs.	
Z 2	Feb. 21			67	Mar. 7, 5 to 6 a.m.	13 da. 21 to 22 hrs.	
AA 1	Mar. 30			Removed		No record.	
AA 2	April 1		39				
BB 1	Apr. 27			Hatched			
BB 2	Apr. 29		28	Hatched		No record.	

¹ This egg removed April 29.

CHAPTER XIV.

ON THE NATURE AND BASIS OF HEREDITY.

Parts of two addresses and a considerable amount of less closely written materials have been seriated by the editor to form the present chapter. The three groups of materials are here placed in the order of their preparation, and under their original titles.

HEREDITY.¹

The subject of heredity covers a wide field, and the central problem has been scarcely more than located. It has long been obscured with traditional myths, which, like other traditions, often live in one disguise or another after they have been repudiated. One of these myths, if one may venture to so classify it, is the idea that heredity stands for "transmission," with emphasis placed on the *trans*.

The Century Dictionary defines heredity as "the influence of parents upon offspring; *transmission of qualities or characteristics, mental or physical, from parents to offspring.*" The essential idea here is contained in the word "transmission." The characters of the offspring are conceived of as inherited, as if they represented elements that belonged primarily to the parents and were by them bequeathed as legacies to their children.

We may flatter ourselves that we have completely outgrown such a crude conception, but the traditional term continues in everyday use, and the traditional idea still cleaves to it. Witness the belief still held by a considerable number of naturalists—which not long ago was so ably championed by Herbert Spencer and as ably controverted by Weismann—the belief handed down from Lamarck, that "characters" functionally acquired during the lifetime of the parents are transmissible to the offspring.

Darwin's pangenesis and the intracellular pangenesis of de Vries represent elaborate systems of transmission, in which the central myth expands into a train of ancillary myths, each designed to conceal the weakness of the mother myth. Darwin ends his discussion of pangenesis with the following words:

"Each living creature must be looked at as a microcosm—a little universe, formed of a host of self-propagating organisms, inconceivably minute and as numerous as the stars of heaven"² (Animals and Plants, II, p. 483).

Darwin's hypothesis represented the germ-cells as composed of these "hosts of self-propagating" pangens, collected from every point in the body. Think of these

¹ The manuscript treating of this topic represents that portion of a lecture at Woods Hole, July 29, 1907, that was reduced to writing (SS 12). It is given first position in this chapter because of its consideration of the more general aspects of development. The method of treating the subject, adopted by the author in these pages, suggests that this material more properly belongs with the chapters on Orthogenetic Evolution, in Volume I. But the fact that three quite different *aspects* of heredity are considered in these three groups of materials led to the conclusion that no one of the three aspects of the subjects should be presented as an isolate. The two additional parts of the chapter are: A part of a lecture (on Mendelian heredity), of February 28, 1908, before the Wisconsin Natural History Society (Z 5), and, finally some short, sketchy materials (I 16, WW 1, EM 9, W 9) which the author had not yet arranged in final manuscript form, but which constitute his last writings and conclusions on matters of much interest to the present volume, chiefly on "germinal weakness" and evidences of it and of its modifiability.—Ed.

² This passage is adopted by de Vries as a motto to adorn the title page of his "Intra-cellular Pangenesis."

hosts of atoms migrating from all parts of the body and assembling in germ-cells. This miraculous migration is then followed in the developing germ by an equally marvelous "distribution" of these atoms to their appointed places. Here transmission includes two distinct steps—a "centripetal migration" and then a "centrifugal redistribution" to points corresponding to the points of departure.

De Vries abbreviates this hypothesis of transmission by cutting out the first step completely, for he imagines that his hosts of unit-characters are located in the nucleus from the first, and hence that they require no transportation from the soma. The myth of centripetal migration is dismissed, but that of centrifugal distribution is retained. The abbreviation, then, although in the right direction, amounts to nothing as a simplification, for miracles are not made more comprehensible by reduction in number.

We have to discard the idea of transmission *in toto*, not only the centripetal migration conceived by Darwin, but also the centrifugal emigration or distribution from the germ-nucleus to the soma.

Every theory founded upon the postulate of unit-characters, or specific determinants stored in the nucleus, is necessarily committed to some form of centrifugal distribution during the course of development; and for each element to be distributed it is necessary to assume either that it is passively transported to its destination or that it finds its own way automatically. In either case it would be nothing less than a miracle for a specific pangen to reach a prescribed point in such a complex mosaie field as the organism represents; and, for this to be fulfilled, not only at the predetermined point, but also at just the moment for harmonious development with its immediate neighbors, with symmetrical and correlated groups, with inter- and intra-locking systems, constituting a microcosmic whole, incomparably more difficult to grasp than the stellar universe—for all this to be fulfilled is utterly beyond the bounds of scientific credibility. To try to conceive of normal development as thus pre-punctuated in all its space and time relations—as proceeding from ready-made elemental characters, automatically distributing themselves or guided by entelechies—is to indulge in ultra-scientific teleology.

When we take from these pangens deities all that speculation has fictitiously injected into them, or wrapped around them, nothing remains but physical elements in self-sustaining organic relations. In brief, we have a primordial germ-cell of the same specific constitution as the mother-cell that preceded it. The mother-cell transmits *nothing*. When it divides into two daughter-cells it merely divides itself, and each moiety has the constitution it had before division. If, then, the daughter-cell is an exact copy of the mother-cell there is no wonder, since it really is the mother-cell in substance, constitution, behavior, and potentialities. It is all this, and yet no transfer of qualities has taken place, and it is plain that *transference or transmission is absolutely impossible, in the nature of the case.*

Our germ-cell, which inherits nothing—unless, under the spell of usage, we must still continue to say that a cell inherits itself—our germ-cell is from the first a living organism, for it has all the fundamental functions of living organisms, such as assimilation, growth, reproduction, etc. It is in the exercise of these functions that development becomes a *progressive elaboration*, with a physical continuity that admits of periods of comparative rest, but not of breaks in causal sequence.

As the organic world must, from the standpoint of evolution, be regarded as a product of the physical world, we have always to take the physical aspects as our point of departure. Our theoretical myths are largely due to reversing this natural mode of procedure, not meaning to imply that from the physical side we always come face to face with facts. Newton's emission or corpuscular theory, according to which light consists of particles emitted from the luminous body, was just as much a myth as the theory of transmission of hereditary qualities. The emission conception proved to be untenable and had to give way to a totally different view, according to which light is not something transported from the sun, but a peculiar self-propagating motion of the ether.

Now, the ether set in vibration at the sun does not of course come to us, neither does the initial vibration ever reach us. A ripple may appear to run over the surface of water, but the appearance is illusive. The ripple is a new ripple at every instant, and its seemingly running crest does not advance at all. So with the vibrations of the ether. Successive particles vibrate in linear sequence, because they are identical in nature and respond alike to the same condition. So also is it with hereditary phenomena. Germ-cells behave alike in development, not because anything is transmitted to them, but because they represent *identical material and constitution*, and are exposed to essentially like environmental conditions.

The development of the germ is said to end in the specific form characteristic of the race. It is well to remember that we have in every development a flowing sequence of specific forms, for every stage is as specific as the end-stage. In this progressive change of form we see an interesting difference between the development of the organism and the development of the crystal; nevertheless, the form is as certainly a physical determination in the one as in the other. The crystal has its specific form and sometimes several specific forms. In every case it owes the form to the nature of its material elements and the conditions under which it arises. We would not think of ascribing its form and symmetry to hereditary transmission; neither would we think of intercalating directing or formative agents, distinct from the material elements composing it.

Fundamentally considered, the organism and the crystal are equally "self-determining" at every step, equally the products of intrinsic physical properties and conditions. The crystal is said to grow by "accretion," the organism by "intus-susception." But this is merely a superficial difference that does not affect the general standpoint. From a physical standpoint the essential thing is not where the elemental particles attach themselves, whether interstitially or superficially, but that they attach themselves in a self-regulating, determinate way, so that the typical form at every step is, to use Jensen's terms, *autogenic* rather than *allogenic*. In other words, the form is a "direct causal result," rather than an indirect one imposed by special mediative factors, such as pangens, determinants, and the like.

According to the view sketched, we see that *recapitulation* in the organic world is a universal phenomenon as fundamental as in the crystal world. It is no hallucination, but the great fact underlying every form of heredity, every form of development, every form of evolution.

Ontogeny is recapitulation from top to bottom. Think how full of significance is the recurrence of the cell-stage as the universal primordium in both plant and animal development. And yet no two species start with germ-cells that could be

interchanged. The germs of different species are specifically unlike, so that although they set out in very similar ways, they gradually diverge and end in all the varieties that inhabit the earth. Relatively slight initial differences are sufficient for greater and greater and more numerous differences as development runs on. All this is to be expected from a physical standpoint; special pangens to steer are superfluous; their theoretical importation explains absolutely nothing, and only leaves us with greater difficulties to account for than the phenomena themselves.

Ontogenetic recapitulation in a given species is most wonderfully exact. It is this perfection of reproduction that *seems* to require some extraordinary or supernatural agencies. We easily forget that *only physical processes can approach such exactness*. It is absurd to think such processes need or can have assistance in reaching exact results. The more we reflect upon this, the clearer it becomes that recapitulation must be physically directed, *i.e.* self-directing.

Ontogenetic recapitulation is, then, a fact that admits of no explanation except from a physical standpoint. In this fact lies the whole of heredity.

Now, while ontogeny is so wonderfully exact that we never cease to be amazed at its performances, we must not forget that germ-cells are subject to slow variation. In fact, it is only germ-variation that has to be considered in phylogeny as in ontogeny. Consequently, when the germ-cell takes a step forward, ontogeny begins with an initial difference that sets the whole series of ontogenetic stages on a diverging line that digresses so little as to be undiscoverable until near or at the end of development.

Succeeding generations start with recapitulation at the new level or at the new point in the same level. As variation in the germ moves, so the recapitulation shifts; to be physically exact it must do so. Variation in results, then, is no evidence of a fault in exactness, and the shift is so slow that recapitulation is closely ideal.

ON MENDELIAN HEREDITY.

In an address of last year,³ I had no occasion to do more than refer to Mendel's brilliant work. Although Mendel did not undertake to formulate any theory of evolution, the problem of the origin of species was certainly in his mind, and he hoped to get some decisive results by crossing varieties or species. A finer model of experimental work and careful analysis has not been seen. The results were very remarkable and are now accorded first rank by many prominent naturalists.

I have devoted a good deal of time during the last 10 years to crossing various wild and tame species of pigeons, and do not intend at this time to go deeply into the subject of hybridization, but may refer briefly to some experiments which lead me to believe that Mendel's experiments with different varieties of peas, important as they are, do not reveal any fundamental and universal law of heredity.

Mendel saw clearly that the problem of the origin of species must be attacked from the analytical and experimental side. The first step, then, was to select particular "specific characters" that were as sharply defined as possible. He selected 7 pairs of contrasting characters. For example: *tall* and *short* stem; *axial* and *terminal* flowers; *smooth* and *wrinkled* seeds; *yellow* and *green* cotyledons; *gray* and *brown* seed-coats; *inflated* and *constricted* pods; *green* and *yellow* pods.

³ This part of the chapter is the latter part of a lecture delivered at the Wisconsin Natural History Society February 27, 1908. (Z 5)

When a tall variety was crossed with a short one, the result was that *all* of the offspring were *tall*; hence the character "tall" was called *dominant*; "short" was called *recessive*. The same result was reached with the other characters. When the hybrids were bred together both characters reappeared, and always in definite proportions: (A) 3 dominants to 1 recessive, (B) 1 dominant : 2 hybrids : 1 recessive.

The fact that the same ratio appeared in each one of the seven sets of experiments seemed to demonstrate several important points: (1) that there was some uniform law governing the results; (2) that specific characters stood for definite units—"purity of germs," as Professor Bateson calls it; (3) there were no transitional phases, no passing of one character gradually into another.

When thus presented, the facts tell strongly against the origin of species by gradual modification as held by Darwin, and strongly support the contention of de Vries for mutation as the mode of evolution. No wonder that the work was hailed with such delight by de Vries and Bateson.

On looking at the two classes of characters—the dominants and recessives—it becomes obvious that the results would not bear out the conclusions. For example, is it not clear that there can be no such impassable limit between "tall" and "short" as claimed? Whatever the ratio discovered means, it can not mean any absolute *impasse* between two such characters. In no case of these contrasting characters does it seem at all probable that there can be no transitional or intermediate conditions.

A simple question as to these pairs of dominants and recessives was this: Could one on hearing the names of the pairs predict which one in each pair would be dominant and which recessive? I took the list given by Mendel, and, before informing myself of Mendel's results, underlined the characters which I conjectured would be likely to be dominant. The guess turned out correct in every one of the seven cases.

The meaning of dominance and recessiveness is, then, only greater or less *vigor*, greater or less *stability*. In the case of "tall" and "short" it is vigor, in the case of axillary or terminal flowers it is preponderance of stability—the older character being the more firmly fixed. This is enough perhaps to be suggestive.

Now, we find differences in vigor and in the stability of characters everywhere, but we do not always get the Mendelian ratios. The ratios we get, if we get any at all, are quite different in different species, and that might have been foreseen. [Here the lecturer continued the subject without manuscript, and but few additional pages (see two paragraphs in advance) were ever written;⁴ the outline from which he spoke is of interest, however, and is as follows.—EDITOR.]

Mention—

(a) Results in crossing: Japanese turtle and blond ring-dove; Japanese turtle and white ring; Japanese turtle and homer; Japanese turtle and common pigeon; Hybrid and homer; White ring and humilis. First generation—dark ♂ and white ♀. European turtle and ring—♂ dark and light ♀. Japanese turtle and ring—♂ dark and light ♀. This seems⁵ to be a general law with pigeons, but I should not dare to say it holds as a universal law.

(b) Sex-alteration." (Z 5)

Mendel⁶ did not undertake to develop a theory of evolution, his aim being to discover the principles that govern hybridization. His experiment with peas, as he

⁴ The first part of Chapter I has a short statement on Mendelian heredity.—EDITOR.

⁵ That is, "dark male and light female" hybrids.—EDITOR.

⁶ Written December 1907 (before, or at the same time with, the immediately preceding pages).—EDITOR.

interpreted them, seemed to indicate that specific characters behave as "pure" and "independent" units. Mendel's results are now being tested in various forms, and it remains to be seen whether he discovered any principle that admits of universal application. So far as my own work goes, I may say I find no evidence of independent unit-characters, and I think that I find abundant evidence that specific characters do not pre-exist in germs, either as specific units or as determinants. In fact, the whole conception of characters as unit-entities seems to me utterly incompatible with what we know of their genesis and history.

It is quite true that as yet we have not seen very much serious work on the genesis of characters. It is very much easier to compile ponderous volumes of reported saltations and discontinuities than it is to trace these appearances to their genetic foundations. The criticism I should make of Mendel's work would be that he did not first study with the utmost care the nature of the characters with which he proposed to experiment.

Furthermore, the claim that any two characters in closely related varieties of peas should be "mutually exclusive" borders on the incredible, and stands in contradiction, as it seems to me, with the very general phenomenon of blending. The conception of characters as indivisible unit-entities seems utterly irreconcilable with all we know of the phyletic derivation of organs and characters. The "principle of change of function," developed so ably by Dohrn in 1875, shows that characters are only local differentiations that arise by slowly modifying processes.

The contrary assumption is the negation of evolution, and opens the way to the realm of miracle. There can be absolutely no hope of ever tracing the genesis of characters from the standpoint of Mendelian purity. We may get allelomorphs within allelomorphs *ad infinitum*, but every "within" hides the truth we are seeking, in essentially the same way that the old preformationists hid one miracle within another in the womb of mother Eve. (Z 6)

Some further data and conclusions bearing upon the preceding theme, and written mostly after the above, have been seriated and given a concluding position in this chapter by the editor:⁷

Mendel emphasized the importance of using safe material, but he overlooked the fact that his peas were *closely related varieties*, which fact may have something to do with *alternative inheritance*. Darwin and others have used domestic species.

"It is willingly granted that by cultivation the origination of new varieties are acquired which, under natural conditions, would be lost. . . . Various experiments force us to the conclusion that our cultivated plants, with few exceptions, are members of various hybrid series,* whose further development in conformity with law is changed and hindered by frequent crossings *inter se*. The circumstance must not be overlooked that cultivated plants are mostly grown in great numbers and close together, which affords the most favorable conditions for reciprocal fertilization between the varieties present and the species itself."

The great variability of cultivated plants is, according to Mendel, due not so much to "simple transference into garden soil" as to the cross-breeding which is thus favored and which is systematically practised by the horticulturist.

⁷ All that follows was written at intervals, and more or less disconnectedly, by Professor Whitman. The editor is responsible for the order and arrangement of the material.

*The italicizing is our own.

It is claimed that the peas form an exception, as their organs of fertilization are protected by the keel. But it is admitted that "even here there have arisen numerous varieties during a cultural period of more than 1,000 years; these maintain, however, under unchanging environments a stability as great as that of species growing wild."

Pigeons present the following advantages over peas in crossing: (1) In peas we can not put the individual to more than *one* test. In pigeons we can test an individual over and over again, one year after another; we can test it with different individuals of its own kind or by various crosses. This advantage enables us to see that the individual carries *different* (not necessarily "pure") germs. (2) Pigeons present phylogenetic stages (ageing), so that an individual gives us two well-marked phases for study—one in the first plumage and another in the second or adult plumage. (3) The characters, although more complex, are more definite, and give more than one differential. These points probably more than counterbalance the reality involved in the objection raised by Mendel and by Bateson that a multitude of characters might be an obstacle to discovering Mendel's law.⁹ (W 10)

De Vries's mutations¹⁰ make it impossible to investigate. Premutations are as immutable as mutations, and they are not supposed to come in gradually, but by a complete and sudden transformation.

Mendelism—pure germs, segregation, etc.—ignores the real thing, namely, *germ-variation*, and refers all changes in characters, in color for example, to germs introduced somewhere in the parent stock. It speaks of reversion, etc., as due to the cropping-up of old germs that have suddenly come into the field.¹¹ Changes due, for example, to weakening by inbreeding are all declared to be "segregation."

WEAK GERMS AND IRREGULARITIES IN DEVELOPMENT.¹²

White color.—Most students of genetics treat white as a character. Now, in albinos or partial albino pigeons and pheasants we have clear evidence that the presence of "patches of white" mean only that the organism is too weak to bring its development to the point of forming the normal color-pattern.

If this pattern represents many specific characters, as it does, then it is evident that in the case of a particular albino pheasant,¹³ to be described in the next paragraph, we have a lack of energy to carry out development, for this same albino gradually, in the course of 2 years, acquired nearly the full normal color with all the

⁹ Why is Mendelism found only in hybrids between "closely related" forms? We may observe that in closely allied species each parent represents *nearly all* of the characters found in the two species. If the two species stand wide apart, then each parent represents only a fraction that might descend to nearly one-half in extreme cases. In other words, the hybrid represents the *sum* of the *different* characters; e.g., suppose that in two close allies each has 10 characters, 9 of which are common; then the sum of the *different* characters would be $9 + 2 = 11$. Suppose each has 10 characters, 5 of which are common. Then the sum will be $5 + 5 + 5 = 15$. Suppose only 1 is common; then the sum will be $1 + 9 + 9 = 19$. The sum will increase as the number of common characters is smaller. Although each species has only 10 characters, the number of characters to be represented in the hybrid will vary from 11 to 19. (X, Z, W)

¹⁰ De Vries's test of species by cross-fertilization can not be applied among the fungi; in many of these there is no fertilization, and when there is, it is self-fertilization. Among bacteria species can often be distinguished only by physiological means.

¹¹ It is probably true that the *species* changes throughout the whole life cycle.

¹² The arrangement of subjects under this heading is that of the editor. The descriptions and headlines are solely those of the author; the italics are also solely his.—EDITOR.

¹³ Many cases are known of old hen pheasants assuming male plumage. No cock pheasants were ever known to revert to female garb.

characters. Here is one case where we see that characters can not be said to pre-exist as definite units, the same bird may pass through several stages of patterns in succession, and we always see the transitions from one character to another. Similar examples could be drawn from the geopelias and other doves.

In 1905 I raised a whitened female pheasant which in her second year became nearly normal in color, but somewhat paler. From her and a normal male I obtained a partial albino male; but, strange to say, this two-thirds white male subsequently assumed gradually the color of the normal male, and finally when 2 years old had lost all white and presented the plumage of a normal male, except that the colors were not quite so dark.¹⁴

Albinism is, then, not one of a pair of opposite or alternative characters; it is only one of many degrees of the same color-character. Black pales to gray, and gray to various degrees of whiteness. In the pigeon the fancier's black, brown-gray, gray, red, yellow, all stand for one and the same kind of melanin pigment,¹⁵ differing only in density, depth, etc. The lighter colors and shades graduate into white, which, when closely examined, usually shows a tinge of yellowish or orange brown. If the pigment granules be examined by transmitted light we get an orange brown; if by reflected light, then black, red, yellow, whitish. Breeding shows that we pass easily from one of these conditions to another. The variations are all quantitative and conditional states of one and the same thing. Mendelian proportions may or may not appear, but these proportions are not to be construed as unit-characters, nor yet as immutable characters. I am convinced that these various shades of color are all due to one and the same character; in the development they are severally presented under different conditions.

In many animals we have a summer color and a winter white. Both are the same character, but in extreme conditions. The degree of exhibition may depend on the degree of heat, light, etc. How much simpler is this view than the assumption of two unit-characters, alternating in the same animal from summer to winter and back.

Physical weakness.—A juvenal pigeon (*OS-D 3-G*) hybrid from a male *orientalis turtur-risoria-alba* (*OS 8-D 3*) and a female blond ring, hatched July 18, 1908, has only 11 tail-feathers and 2 abnormal toes. The fourth toe of each foot has an abrupt bend at the end of the basal third, the distal two-thirds taking a direction nearly parallel with the middle or third toe. The result is "symmetrical" on the two sides. The tail, toes, and rather small size all indicate that this bird owes its deformities and deficiencies to *weakness in development*. (W 9) (The color of this bird—see table 57—too, was an abnormal gray, found in one other of its many sisters and brothers. This gray-colored bird (*OS-D 3-G*) arose almost immediately before a period of complete failure of developmental energy; the other abnormal gray was from the first egg after this period that was able to develop at all.—EDITOR.)

Weakness in common pigeons is frequently expressed in white color. Some white pigeons fail to get an orange-red iris. The irides of white ring-doves sometimes remain dark; the same is true in some common pigeons.

¹⁴The author has recorded several instances of the appearance of white color due to quite temporary or accidental causes. It seems hardly necessary to refer to such cases in this work, since similar cases are well known to all naturalists.—EDITOR.

¹⁵The editor has presented (Biol. Bull., 1909) evidence from chemical and developmental standpoints for this same conclusion, which was reached earlier by Professor Whitman.—EDITOR.

In a pair of young pouters from gray (white-barred Brünn) pouters, one (8) is gray with dark bars, and in form is apparently very well developed;¹⁶ the other (9) is white, with poorly developed wings, the primaries being imperfectly developed.¹⁷ This bird has the "shakes"; that is, it trembles all over and can not control the movements of the head (I have had two such white birds from a dealer, and they are evidently of the same nature). This bird was hatched October 11, 1908, and at the age of 5 to 6 weeks, though of good appetite, was quite unable to fly. This white pouter died January 27, 1909, and turned out to be a female, as was its nest-mate, both hatched in *October* 1908.

In another case a pair of birds consisting of a male *orientalis* \times *risoria* hybrid (8) and a female *St. alba* hatched both eggs of a clutch on June 5, 1908; and again both eggs of another clutch on July 7. They laid again (third time) July 22 and 24, when the young from the second clutch were only about 2 weeks old and not yet out of the nest. This set of eggs, produced so early after the preceding eggs, failed to develop. Either this was due to the presence of young in the nest (the latter would prevent steady sitting) or to weakening of the germs (late in season) and to the strength of the old birds being reduced by the care of vigorous young.

Short abnormal legs.—In several crosses between common pigeons (*C. livia domestica*) and *T. orientalis* of Japan, I have had young hatched with legs abnormally short, so that in course of a few days, as the body rapidly grew, the legs came more and more to point more or less directly backward, and to be of no use in enabling the bird to reach up for its food.

So far as memory and some records serve, this condition did not appear in any of the first offspring raised in the better part of the season—April to June—but in the later offspring of July and August. This deformity may, then, be ascribed to failing or diminished *germ-energy*.

This view is confirmed again this season (1909) in a cross between a homer and a hybrid between *T. turtur* and *T. orientalis* (TO 8). The products of this cross (up to July 22) are as follows:

- First set of eggs, April 12 to 14, normal development.
- Second set of eggs, April 22 to 24, normal development.
- Third set of eggs, May 1 to 3, normal development.
- Fourth set of eggs, May 16 to 18, normal development.
- Fifth set of eggs, May 28 to 30, normal development.
- Sixth set of eggs, July 1 to 3, first, short legs; second, legs normal.

Note that I have worked these birds abnormally rapidly, and probably that, added to the usual strain, has been sufficient to weaken reproductive power. In the earlier part of season transference of eggs is followed by immediate renewal of the nesting cycle. In the later part of season the birds lose a week or more before renewing their efforts.

Distorted development, wry neck, dolicocephalism.—In 1906 I mated an imported male Japanese turtle with a female hybrid (SO 2) obtained in 1904 from a cross of *St. risoria* and *T. orientalis*. The result was one secondary hybrid ($\mathcal{C}O$ -SO 2-B) which was able to live and mature. This bird has thus far proved *infertile*. He

¹⁶ A neat bird but a degenerate, as shown by color and also by her early failures to produce eggs.

¹⁷ The feathers of this bird were slow and irregular in growth; it was never able to fly, though it lived $3\frac{1}{2}$ months. It was kept in the house and well cared for; no cause of death but weakness. The legs sprawled, so that walking was awkward and difficult; it was shaky like a fantail, and the primaries hung loosely apart.

showed the following marks of weak development: (1) the head is not quite erect, but has a noticeable cant to one side; (2) the back of the head is rather too large for the fore part; (3) a median crease, or division between the feathers of the breast, has never wholly disappeared, as it normally does with young birds becoming adult; (4) this bird has shown for a short time each season a desire to mate, but he has not been as energetic and persistent as perfect hybrids are.

Wry neck, complete lack of coöordination of head and limbs.—A young hybrid (*O 6-SO 2-B*) hatched June 14, 1908, from a cross of a male *T. orientalis* (66) and female *risoria* × *orientalis* hybrid (2). It died at the age of only 5 weeks and 3 days. This bird showed deformities as follows: (1) the neck began to be bent to one side (left), the head being held with beak turned to the right; (2) the left eye (lower) seemed to be blind some time before death; (3) the legs sprawled apart and soon became of no service, the bird usually lying on its ventral surface supported by one or the other wing, the head usually resting on the floor; (4) the bird had to be fed by hand after about 10 days, since its head was so twisted that it could obtain no food from the old birds. It became quite accustomed to my feeding it and was quite eager for its food. In trying to move, however, the bird could only flop around, much as a headless fowl. It was utterly incapable of a single normal movement, except that it would open its mouth widely for food when I grasped its bill. The bird was faithfully fed along with a young white-faced pigeon. (5) It was dolicocephalic; the back of the head was prominent and bulging like the hybrid of 1906, referred to above. The wings were symmetrically developed, as was also the beak.

Here we see a distortion in the neck growing worse day by day until the end. The system of developmental processes is, at the beginning, a little unbalanced; later the distortion increases. The "character" is not then a "unit" at first, but something induced probably by weak organization.

Cross-bill.—The crossed-bill has been seen in several juvenal common pigeons; the curvature in one case amounted to nearly 90°. This deformity becomes visible a day or two after birth, but in some cases is already well-marked a few days before birth, as I learned through the following case: The second egg of a pair of hybrids (namely, *turtur* × *orientalis* × *homer* × *ring*) was laid July 9, 1908, and failed to hatch; after waiting an extra day I opened the shell and found the bird dead, but developed up to within about 2 days of the time to hatch. This bird showed a quite definite curvature in the upper mandible, which turned to the left.¹⁸

Infertility.—Developmental processes run on to different lengths. If equilibrium is disturbed, the deflection may become worse and worse—the deformity, being a local weakness, becomes less and less capable of veering to the normal. Do developmental processes run on continuously? An affirmative answer is given as a result of pulling out some of the first feathers prematurely. The color-pattern is thus found to have made progress in the feathers that follow.

Developmental processes may be arrested by cold or otherwise. May the same process run to different lengths, according to the greater or less strength or

¹⁸ In 1911 the editor recorded two cases of "curved-bill"—not certain whether "crossed"—in two unhatched birds from a mating of a male *St. alba* and a female *alba-orientalis* hybrid. Since that time a considerable number of cases of true "cross-bill" have been observed in various hybrids.—EDITOR.

energy? I think the male in many species of birds passes directly through and beyond the female stage. In many cases even the females may now and then pass beyond the normal female and advance towards the male condition. The energy of development and degree of fertility appear to be correlated. (W 6)

If fertility is a thing of all degrees, and that too within the limits of a single species, are not the qualitative distinctions inferred therefrom likewise things of degrees, and variable within the same limits? If fertility may vary individually, as is certain, is there any reason to doubt that its physical bases are equally variable from individual to individual? But fertility varies also according to age, conditions of food, temperature, etc. How then can qualitative differences be an infallible criterion of species?

We have weakness, not only in ova, but also in the spermatozoa of hybrids. Guyer¹⁹ showed that the sperm of hybrids (from wide crosses) do not come to full development. The hybrids on which he worked were hybrids between common pigeons and ring-doves, and these hybrids are practically all males. Among other hybrids from very wide crosses (as the common dove and Japanese turtle) I have had one fertile male. In hybrids between ring-doves and Japanese turtles I have had quite a number of fertile males and some females. As hybrids are taken between more and more nearly related species the sperm rises to more and more perfect development. As development is more complete, energy is more complete and fertility becomes highest.

Early fertility is often followed by later infertility.—For two years (1907 and 1908) I have mated a male Japanese turtle with a female hybrid between the Japanese turtle and a ring-dove. Each time fertility has been equal to development and hatching in the height of the season; then perhaps a few eggs were fertilized, but this gradually fell short, until no sign of beginning development could be seen. *This means that the season of greatest vigor of the birds is the season of highest fertility.*

Infertility may often be found associated with "weakness." Birds in the first breeding season do not do as well as when they are 3 or 4 years old; only then do they come to fullest maturity, and they then have all their surplus energy for reproduction.

Just as energy gives fertility, so it carries development to different heights, e.g., males above females.²⁰ Birds of resplendent plumage or increased number of feathers (fantail, Japanese cock, peacock, etc.), are birds that have attained greater and greater developmental energy. In the same way those *tissues of greatest energy* carry the number of parts, and differentiation, to the highest points.

Problems of evolution are to be slowly approached through observation, experiment, reflection, and theory. Their solution will tax the resources of the laboratories in every department of biology, indeed of every department of science; and

¹⁹This author has since called attention to the fact that in still some other *orders* of birds a majority of hybrids are males.—EDITOR.

²⁰"The coexistence of the sexes is known in a number of instances. Nansen showed that *Myxine glutinosa* is a male until 32 cm. long, and thereafter produces ova. In some cases only male cells are produced. This does not look like sex-determination by a special chromosome. Schultz, working with *Microstoma*, showed that in rare cases, when fission begins, the anterior zooid is male, the posterior female. Ishikawa (1891) showed that in the shrimp *Gebia* the gonad has anterior testicular and posterior ovarian parts." (XZ 4)

not the laboratories alone, but the laboratories reinforced and supplemented by every method of research in the study of *living organisms*.

There is no one highway to solution. We can not circumvent it by curves of probability. The philosophy of chance is wholly superficial. The more we know the less room there will be for chance. It is our business to eliminate chance by tracing the *history* of the elements supposed to obey chance.

In studies on evolution our material, first of all, must be selected with a view to eliminating chance. We must work with *pure species*—that is, with wild species rather than domestic mix-ups. Purity in species means that we can know something about our subject. Some wild species are mix-ups; they can not be our main dependence. Their behavior must be judged by that of better known forms.

Variation is not chance, and fluctuation is a thing to be studied. The more we lump things and hide details the more we get lost in the wilderness of chance.

CHAPTER XV.

DESCRIPTIVE AND HISTORICAL ON THE SYSTEMATIC POSITION OF CERTAIN RING-DOVES.¹

The genus *Turtur* is broken up by Salvadori² into the subgenera *Turtur*, *Homopelia*, *Streptopelia* (collared turtles), *Spilopelia*, and *Stigmatopelia*. Salvadori, however, continued the use of *Turtur* as the generic name of all the species included in the five groups. I have preferred to treat them as five genera.

THE BLOND RING DOVE (STREPTOPELIA RISORIA).

Salvadori does not regard this bird, more often known as *Turtur risorius*, as a distinct species, for he says (footnote, p. 414): "It is uncertain to which species the tame dove belongs," and gives in the same footnote the synonymy which applies to it.

Thirteen species are named under the subgenus *Streptopelia*, and *T. risorius* is supposed to belong to one of these, but which one is not even suggested. In the long list of synonyms I see that the bird has been named as follows:

- Linnæus, *Columba risoria* (S. N. I., p. 285, N. 33) in 1766.
Buffon, *Tourterelle à collier* (Hist. Nat. Ois., II, p. 550) in 1771.
Latham, *Collared turtle* (Syn., II., 2, p. 648, W. 42) in 1783.
Selby, *Turtur risorius* (Nat. Libr., Pigeons, p. 170) in 1835.
Bonaparte, *Streptopelia risoria* (Conspl. Av., II., p. 65) in 1854.

In a further footnote (p. 415) Salvadori remarks: "This bird has become very common everywhere in a domesticated state." His description of this dove (same footnote) is as follows:

"*Adult male*.—Upper parts yellowish bay or isabelline, greyer on the outer wing-coverts and secondaries; a broad black collar, edged above with whitish grey, on the hind neck; throat almost pure white; breast pale isabelline, changing into white on the abdomen, vent, and under tail-coverts; sides pale grey; under wing-coverts pale grey, almost white; primaries pale brown; central tail-feathers isabelline grey, the lateral ones darkish grey, changing into white toward the tips; outer web of the outer tail-feather almost white; tail below blackish at the base, the black sharply defined from the apical half, which is white, but tinged with grey near the black part; bill light horn; irides orange, feet pink-red. Total length about 10 inches, wing 6, tail 4.5, bill 0.6, tarsus 0.85.

"*Female*.—Similar to the male, only somewhat smaller."

The white ring-dove is regarded by this author as a variety of *T. risorius*.

Salvadori notes that the following hybrids of the blond ring-dove have been obtained:

1. *Edopistes migratorius* ♂ × *T. risorius* ♀ (Mitch., P.Z.S., 1849).
2. *C. livia* var. *laticauda* ♂ × *T. risorius* ♀ (Dr. Günther).

The range of *Streptopelia* is given by Salvadori, but he says nothing about that of *T. risorius*. The range of the subgenus *Streptopelia* is: "Africa, S. W. Palaeartic

¹ The inclusion of the materials of this chapter in the present volume seems advisable for the following reasons: (1) The "collared" ring-doves have been very extensively used in the breeding data with which the volume chiefly deals. (2) The names of these doves are considerably confused in the literature. (3) The specific value of the blond rings and white ring-doves, which are treated in this volume as species, has not been conceded by most writers. (4) It seems necessary to present Professor Whitman's conclusions on these matters, and to publish what he has added toward an adequate description of these forms. (5) Much of the literature touching these matters is so little available to most of those biologists who will make use of this volume that the extensive quotations herein contained seems warranted.—EDITOR.

² Catalogue of Birds in the British Museum, Vol. XXI, 1893.

Region, Indian and Oriental Regions, Indo-Malay Archipelago, and also Marianne or Ladrones Islands."

Brisson³ on the collared turtle (La Tourterelle à Collier).—The blond ring-dove was named *Turtur torquatus* by Brisson, and described as follows:

"Columba superne ex alba rufescens, inferne alba; collo inferiore et pectore albis ad vinaceum tendentibus; collo superiore torque nigro cincto. *Turtur torquatus*.

These common and scientific names were further noted:

Turtur Indicus Aldrovandi. Avi., t. II, p. 508, 1645.

Columba Turtur Indicus Aldrovandi. Klein. Avi., p. 119, No. 13, 1750.

Turtur Indicus Aldrovandi. Willughby. Ornithologie, p. 134, 1676.

Turtur Turcicus Schwenckfeld, Avi. Sil., p. 364, 1603.

Tourterelle des Indes Albin. Hist. Nat. Oiseaux, t. III, p. 19, 1750.

The Germans are stated to call it *Turkeisch-Teublin*; Schwenckfeld calls it *Indianisch-Teublin*; Frisch uses *Lach-Taube*. The Silesians know it as *Lachendes-Teublin*; the English as *Indian turtle*; and Willughby calls it the *turtle-dove* from the East Indies. Brisson gives the following description:

"It is a little larger than the preceding (*Turtur turtur*). Its length from the tip of the beak to the end of the tail is one foot; to the end of the toes, nine inches. The beak, from the tip to the angle of the mouth, is ten lines in length; the tail, four inches and three lines, the tarsus (pied) ten lines; the middle of the three anterior toes, including the nail, thirteen lines; the lateral toes are a little shorter, and the hind toe is shortest of all. Wing expanse is one foot and eight inches. The wings, when closed, extend a little beyond half the length of the tail. The upper parts of the head and neck, the back and the wing coverts are reddish, or a light color verging to reddish. The under front part of the neck and the breast are light with a slight vinous tinge. The abdomen, the sides, the legs, and the lower coverts of the tail are white.⁴ The rump inclines a little to brownish-grey. The flights are of the same color with the outer border whitish. The tail-feathers are ashy-grey above, and all except the two middle ones are tipped with white; below, they are blackish at the base, then of a light grey, passing into white at the tip, the outer one at each side having its outer web white. The upper (hind) part of the neck bears a black collar of about two lines in width. The iris of the eyes is of a beautiful red; the beak is blackish; the feet red, and the nails yellowish green.

"Die female is distinguished from the male by its paler color.

"A variety of this species is the *Turtle Mule*, *Turtur hybridus* (Brisson), or *Turtur mixtus*, Schwenckfeld. This *Turtle Mule* is called *Zwitter Turtel-Taube* by the Germans.

"It is of the same size as the *Collared Turtle*. The top of the head, the neck, and the breast are of a vinous color. The back is wholly ashy and without spots, but a light tinge of obscure reddish is perceptible. The abdomen, the under side of the wings, and the end of the tail is of the same color as the *Collared Turtle*. The flights are dark, the feet blood-red, and the beak bluish-brown.

"This variety arises from the union of a male Common *Turtle* and a female *Collared Turtle*."

Brisson makes no statement as to the place of origin of the "blond dove"; but, as all the authors cited by him seem to follow Aldrovandi in ascribing to the bird an Indian origin, Brisson's silence may be construed as acquiescence in this view.⁵

Temminck on the blond ring-dove.—In his "Histoire Naturelle Generale des Pigeons" Temminck⁶ calls this bird the "blond dove" (*Columbe blonde*), and adopts the systematic name given by Linnaeus, viz., *Columba risoria*, although he ascribes it to Latham. Synonyms, *Columbe blonde*, *Columba risoria* Lath., are given in the index (pp. 481, 482). His account follows.

³ Ornithologie, Vol. I, Paris, 1760.

⁴ White here means light-colored, i.e., pale or whitish-gray.

⁵ Recently W. Kobelt ("Die Verbreitung der Tierwelt," Leipzig, 1902, p. 80) has given the following opinion "Die Heimat der echten Laeptaube, von der unsere zahmen Exemplare stammen, ist Ostafrika; nach Deutschland verfliegt sie sich äußerst selten einmal." In this statement Kobelt probably depends on Brehm.

⁶ Vol. I, 1813, pp. 323-332.

"We cannot well understand the reasons which led Buffon to regard the Collared Dove (*Columbe à collier*) as a second race, or a constant variety, within the species of our common Turtle;⁷ and still less how this celebrated naturalist could assert that this dove is found in our clime. However, it is uncertain that these pigeons do not form a race or constant variety of our common Turtle,⁷ since it is with some difficulty that we succeed in getting hybrids (*métis*) by crossing these species—hybrids which are obtained only through the skilled care of man, and which nature never would have been able to produce. Moreover, the common Turtle is native to our clime, while the other is only kept in cages, where it reproduces under the care which we are accustomed to bestow upon it.

"The species which forms the subject of this article has, then, been imported from warm countries, as indicated by its sensitiveness to cold even now, after a domestication which seems already quite ancient. We recognize this bird, unmistakably, in the description which Brisson gives of the 'Collared Turtle of Senegal,' a species which Buffon incorrectly identifies with his 'Tourterelle du Senegal' (colored plate, No. 160). We have already spoken of this error of Buffon in the article on the *Emerald Dove* (*Colombe Émeraudine*). A modern naturalist,⁸ to whom natural history is already indebted for several interesting discoveries, has found the species here under consideration living in full freedom and breeding in a wild state in the midst of the ancient forests of southern Africa. Thunberg⁹ has found this Collared Turtle in all the southern countries of Africa. It delights especially in places covered with bushes. This bird, he says, never changes place without laughing afterwards, and on this account has received the specific name, *risoria*. Its laugh and its hou-hou make known its place of retreat. Its flesh broiled is quite dry.

"Taking these facts in connection with the domestic state in which this pigeon is found everywhere else, we may assume that the species is native to Africa, and consider the bird described by Brisson, under the name *Tourterelle à Collier du Sénégal*,¹⁰ as well as that described by Le Vaillant, in pl. 268, as the type of our Collared Turtle.

"Sonnini informs us that he has seen Collared Turtles in Egypt, where the inhabitants are very fond of them, and take special care of them. We do not know whether this author has seen the species at liberty, or reduced to a state of domesticity, as it is with us.

"As the name 'Collared Dove' would apply to several other species, which have the collar on the back of the neck, we prefer to follow the example of Le Vaillant and adopt the name 'Blond Dove' as the more proper one for this species.

"Le Vaillant has met with Blond Doves only on the borders of the Great Namaqualand. They are smaller than those we rear in domesticity, but their cooing is absolutely the same. They nest in trees, build a flat nest like those which our Turtles construct, and lay two wholly white eggs.

"This species measures in length ten and one-half inches; the wings in repose, six inches and three lines. The whole plumage is of a pretty pearl gray, shaded with a delicate purplish tint, whitening on the forehead and the lower parts, and taking an isabelline fawn-color on the back and wings. The remiges are dark, bordered with fawn. The feathers of the tail are ashy above, and all, except the two middle ones, tipped with white; the external one of each side has its outer web white. The upper part of the neck is encircled with a black collar about two lines in width; the bill is blackish, the iris and the feet are red.

"The female differs little from the male, except that its collar is narrower, and the breast has a clearer color.

"The male is very fond of his mate; he usually keeps near her, especially during the night, and tries to show her his love through notes that bear some resemblance to a

⁷ *Turtur turtur*.

⁸ Probably Le Vaillant (see his *Introduction*, pp. 11-12.)

⁹ *Voyages au Japon par le Cap de Bonne Espérance*, Tom. I, p. 330.

¹⁰ This bird was *Turtur vinaceus* according to Salvadori (synonyms), Catalogue of Birds, XXI, p. 428.

burst of laughter. He gives besides, a plaintive note, but one which is not disagreeable and which may be rendered by the syllables *kukuruku*.

"The Blond Dove, like many other birds, is liable to take a wholly white color. In this condition it would be easy to confound the species with the true White Dove, which is always of this color; but it will suffice to say here that, without taking note of the size or form of these birds, which differ considerably, it is nevertheless easy to distinguish the White Blond Dove. In addition to the facts that the whole mantle and the wing-coverts always preserve in this bird a delicate isabelline tint, and the proximal parts of the tail feathers are of a more grayish tone, it is still further distinguished by small feathers which form the collar, these always being shaded towards the tip with a tint less white."

As the collared turtle of Senegal, figured and described by Brisson, has been pointed out by Temminck in the above-quoted remarks as the "type" of the blond dove, Brisson's¹¹ description is here given in full:

"*La Tourterelle à Collier du Sénégâl—Turtur torquatus senegalensis.*¹² *Columba superne griseofusca, inferne sordide alba; remigibus fuscis, oris exterioribus sordide albicantibus; collo superiore torque nigro cineto.*

"It is nearly of the size of the merle. Its length, from the tip of the beak to the end of the tail, is nine inches and six lines; to the end of the toe-nails, seven inches and eight lines. The beak, from the tip to the angle of the mouth, is nine lines long; the tail, three inches; the tarsus (pied) nine lines; the middle of the three anterior toes including the nail, ten lines; the lateral toes are a little shorter, and the hind toe still more so. The wings closed extend to about half the length of the tail. The head, the neck and the breast incline to a vinous color, slightly browner on the upper parts of the head and neck. The back, rump, upper tail-coverts, and wing-coverts, are grayish-brown. The abdomen, the sides, the legs, and the lower coverts of the tail are of a dirty white. The under wing-coverts are ashy. The flights, primaries as well as secondaries, are blackish-brown with whitish edges (blanc sale). The two central tail-feathers are grayish-brown, and the lateral ones are black for about two-thirds their length, then gray to the end; the outer web of the outer feathers of each side, also gray. The upper part of the neck bears a black collar about three lines in width. On the sides of the neck this collar ascends a little towards the head.¹³ The beak is blackish, feet red, nails brown. It is found in Senegal, from which country it was sent to Réaumur by Adanson."

The uncolored figure of this pigeon, given by Brisson (drawn and engraved by Martinet, probably from a mounted skin), is too characterless a picture to serve for identification. The shape and proportions of the head and beak would never suggest close affinity with the common blond dove. The description, although inadequate, when supplemented by the observations of Le Vaillant and Thunberg on the voice and the behavior (as reported by Temminck), certainly seems to support Temminck's identification of it as the common blond ring. The habit of giving a laughing coo after every change of position is so characteristic of the blond ring-dove that it may be taken as very reliable evidence of close consanguinity. Brisson offers no suggestion on this point. The black streak in front of the eye is an obstacle, however, to identifying it with *St. risoria*. The light edges of the quills is a much less important distinction, as it applies to many species, and varies much even within the same species. The Japanese ring-dove, so far as form, size, and color are concerned, might be the real wild species of *St. risoria*; but its voice differentiates it and makes identification impossible.

¹¹ Brisson, *Ornithologie*, vol. 1, 1760, pp. 124-125, pl. xi, fig. 1.

¹² We think this may, or may not, be the *Turtur vinaceus* as listed by Salvadori (p. 42S).

¹³ This is a peculiarity unknown in any other turtle-dove and possibly the appearance here noted was due feathers pulled out of place in the specimen described.

The black streak in front of the eyes is not mentioned by Brisson or by Temminck. Possibly the *Turtur torquatus senegalensis* of Brisson is not the *T. vinaceus* of Salvadori.

Linné¹⁴ on *Columba risoria* (*collared turtle*).—

"Brown, beneath grey-claret: crown grey; black crescent on the neck above (behind), spotted (bordered) with white; lateral tail feathers black, spotted (tipped) with white. Inhabits Europe and India; larger than the Turtle-dove (*T. turtur*). Bill blackish; irides red; body beneath white; rump and quill feathers¹⁵ grey-brown; tail sinereous, the lateral feathers tipped with white."

Buffon.¹⁶—The blond ring-dove was regarded by Buffon as a race or a variety of the type represented in the common turtle of Europe (*Turtur turtur*).

"In the species of the turtle, we recognize two races or constant varieties: the first is the 'common turtle,' the second is called the 'collared turtle,' because it bears upon the neck a sort of black collar. Both are found in our climate, and when mated together they produce a hybrid. The one described by Schwenckfeld, which he calls *Turtur mixtus*,¹⁷ came from a male common turtle and a female collared turtle, and took after the mother more than the father. I do not doubt that these hybrids are fertile, and that they return to the race of the mother in the course of some generations."

Selby¹⁸ on the *collared turtle* (*Turtur risori*).—The following synonymy references and descriptions are given by Selby:

"*Columba risoria*, Auct.; *Turtur torquatus Senegalensis*, Briss., I, p. 124, t. II, f. I; *Columbe blonde*, Temm., Pig., I, p. 323; *Tourterelle à collier*, Buff., Pl. Enl., No. 244; *Boitard et Corbié*, Monon. des Pigeons, p. 236, pl. 25.

¹⁴ From a very remote period this species appears to have been domesticated, or rather kept in that state of captivity in which it is retained at the present day; for there is every reason to suppose that the turtle-dove adverted to in Holy Writ may be referred to the same bird, as it is still abundant in Egypt and other parts of the East, where it is fostered and cultivated with care, and it is certain that many of the representations in the works of ancient art, where the dove figures as the emblem of tenderness and affection, or where it is depicted as the appropriate attendant of Venus, are accurate delineations of the collared or domestic turtle.

"This bird does not appear to be susceptible of that attachment to its home or place of birth for which the common or dove-cote pigeon is remarkable, and which peculiar quality renders that species so serviceable to man. On the contrary, like its congener the common or wild European turtle (*Turtur communis*),¹⁹ it can not be left to range at perfect liberty without the danger of its flying away to return no more, and must therefore be kept constantly confined either in cages or in aviaries adapted for that purpose. In this state of captivity, if properly attended to, it breeds with facility, sometimes producing as many as 8 broods within the year; but, being a native of warm climates, and very impatient of cold, it is seldom cultivated to the same extent in this country as it is in those where the temperature is better adapted to its constitution. The male shows great tenderness and affection to his mate, and is constantly by her side, soothing her with caresses or paying court by soft cooing notes, and that peculiar cry so expressive of laughter, and from which it takes its specific name.

"In its wild or natural state it is found in various parts of Africa, and we have by us specimens from the southern part of that continent, a description of which, as varying in depth and intensity of color from the domestic variety, is here subjoined.²⁰

¹⁴ Syst. Nat. (translation by Turton of last edition by Gmelin, London, 1806, p. 478).

¹⁵ These feathers in *T. vinaceus*, according to Linne (p. 474) are "edged with whitish." Brisson describes the edges of the same feathers as "blanc sale"; Selby (p. 172) as "greyish-white." Salvadori (p. 429) says, "All the quills with narrow light edges." Reichenbach (Tauben, 1862, p. 741) says the chief distinguishing mark is "die auffallend weissen Säume der Schwingen." This character, as described by most authors, would not stand in the way of Temminck's view that this species represents the type of *T. risori*. The "streak of black" in front of the eye, however forbids this identification.

¹⁶ Hist. Nat. Ois., II, p. 550, 1771.

¹⁷ Theriotrop. Sil., p. 365.

¹⁸ P. J. Selby, The Nat. Hist. of Pigeons, Vol. V of the Naturalists Library, Edinburgh, 1835.

¹⁹ That is, *Turtur turtur*.

²⁰ This was probably *St. rinaceus*.

"The length is about 10 inches. The chin is whitish; from the corners of the mouth to the eyes, is a narrow streak of black.²¹ The cheeks, neck, breast, and belly gray tinged with vinaceous or pale purplish-red; the hind neck with a demi-collar of black, some of the side-feathers composing it being tipped with white. The back, scapulars, and rump are of a pale clove-brown, with a greenish tinge. The margins of the wings, the greater coverts, and under wing-coverts are blue-gray. The greater quills are hair-brown, delicately edged with grayish white. The tail is slightly rounded, the two middle feathers entirely clove-brown, the remainder on each with the basal half black, the tips bluish-gray, except those of the two outermost, which are white. The vent and under tail-coverts are white, the legs and feet gray (?); the inner toe a little longer than the outer. In its natural state it inhabits the woods, where it breeds, making a nest similar to that of the common turtle, and lays 2 white eggs. It seeks its food in the open grounds, and subsists upon grain, grass-seeds, pulse, etc. It is easily distinguished, and the place of its retreat soon discovered by its cooing notes, one of which we have already stated to resemble the human laugh.

"A mixed breed is sometimes obtained between this species and the common wild turtle, but the progeny are invariably mules, and incapable of further increase, a fact that has been established by many careful and oft-repeated experiments, and one which affords a strong argument against the supposition that many of the varieties of the common pigeon, or of the domestic fowl, are the result of a mixture of different species.

"Besides the wild turtle known to us as a regular summer visitant in the southern districts of England, the *Columba maculicollis* and the *Columba aurita* of Temminck and several others belong to the group, of which the present species may be considered a type."

More recent authors by no means agree in the use of common names for this ring-dove. Mr. F. Finn,²² of the Indian Museum, Calcutta, calls the ring-dove the "domestic turtle-dove." Of the domestic ring-dove he says: "It is certainly not identical with the wild *Turtur risorius*,²³ so far as the note goes; this being a very marked point of specific difference in all the ring-necked species of *Turtur* I have seen alive." Salvadori uses the name "tame turtle-dove." Stejneger uses "ring-dove" for the domestic bird; "ringed turtle-dove" for the wild species of China and Japan. I think "turtle-dove" may be reserved for all the true turtle-doves having two side-spots on the neck, and "ring-doves" for all doves with a half-collar. "Turtle-dove" for "ring-dove" leads to confounding the latter with the turtle-dove. The common cage ring-dove, *St. risoria*, I call the blond ring-dove. (H 6, W 10)

THE WHITE RING-DOVE (STREPTOPELIA ALBA).

Temminck.—A short chapter by Temminck²⁴ is devoted to the white ring-dove, which he regards as a distinct species, and to which he gives the name *Columba alba*. The chapter follows in translation:

"*Columba blanche, Co'umba alba, Mihi.*²⁵

"We give to this well characterized species the name White Dove, because, in fact, it is always and wholly of this color. It is surprising that this little dove has always been confounded with the Blond Dove, which is liable to have a white plumage. We have already spoken of this variety; but it seems necessary to repeat in this chapter the remark, that the White Blond Doves are distinguished at first sight in this, that the mantle, the wing-coverts, the rump, and the two middle feathers of the tail, always preserve a slight isabelline tint, and that the proximal part of the tail is of a more grayish tone. They are further distinguished by the more sombre color of the small feathers which form the collar. If we take

²¹ This is a mark never found in *St. risoria*.

²² "The Cage-Birds of Calcutta." The Ibis, 8th ser., Vol. 1, No. 3, 1901.

²³ I suppose Finn here means *T. douraca*.

²⁴ Vol. I, 1813, pp. 333-335.

²⁵ This dove was named *C. veneris* by Boitard and Corbié (p. 237, 1824) and regarded as a variety of *Turtur risorius*. See their statement in the pages which follow.

no account of these differences which are found only in the more or less bright colors of the plumage, and which are liable to vary in different individuals, it will still be easy to recognize the species here considered.

"The White Dove is smaller than the Blond Dove; it is an inch less in total length, and its tail is shorter. Its wings, longer in proportion, reach back three-fourths of the length of the tail, while the wings of the Blond Dove end at about the middle of the tail, which in this species is lengthened and more tapered. Finally, the White Dove has a milk-white plumage throughout, the feet are rose-red, the iris is red, and the bill is dusky red.

"Sonnini has represented in his plate 67, fig. 1, our Blond Dove, and in fig. 2 the White Dove. The characteristics in respect to form, which serve to distinguish these two pigeons, are there perfectly portrayed. The White Dove appears to be a native to China. It is often found represented on papers and tapestries made in that country.

"Dufresne, of the Museum of Natural History, has shown us two very exact pictures of these birds in two different collections of original designs painted by the Chinese. In our climate the species is reduced to domesticity; these birds are seen only in cages. They are very sensitive to cold, which they seem to endure less easily than the Blond Doves."

Boitard and Corbié.—In a classical monograph of the pigeons, entitled "Les Pigeons de Volière et de Columbier" (1824), these authors²⁶ give brief accounts of both blond and white ring-doves, adopting the name *tourterelle à collier* for the one and for the other inventing the new name "dove of Venus" (*Columba veneris*). These authors regard the white dove as a variety of the blond dove, and herein disagree with Temminck. They give several points of interest in the natural history of these doves and to some extent supplement Temminck's account. Their words are:

"Tourterelle à Collier; *Columba risoria*, Lath. *La Tourterelle à Collier*, Buffon, Pl. Enlum. No. 244. La Tourterelle grise des marchands, et la Tourterelle blonde.

"It is a little larger than the preceding (European Turtle); pale reddish in the upper parts, with a slight vinous tint on the breast and front side of the neck; whitish below. Feathers of the wing brownish-grey, bordered with a paler color; those of the tail ashy and tipped with white, with exception of the two middle feathers; with a narrow black collar on the back of the neck. Bill grayish, darker towards the point. Iris and feet red. The collar appears in the young only after the first moult.

"This species and the following variety are those so commonly reared in cages and aviaries, where, excepting the time of moult, they breed regularly every month, if care is taken to keep them in a warm place. The cooing of these birds is so wearisome and annoying that, despite the great facility with which they become tame, despite the grace of their form and the gentleness of their manners, one easily tires of them, if they are not kept confined in a place set apart.

"In Egypt they are very common, and it seems that through special care, the inhabitants have succeeded in attaching them to their aviaries, which they never abandon, although left free to go out and fly about the fields.

"The Collared Turtle is found in a state of nature in the Indies, Barbary, Senegal, and perhaps all Africa. As we have said, one easily succeeds in crossing it with the Wood Turtle (*Turtur turtur*), but the hybrids thus produced are infertile and cannot therefore reproduce their variety, or form a race, as supposed by Buffon.²⁷

²⁶ Pages 236, 237.

²⁷ Buffon (Hist. Nat. Ois., I, p. 551, 1771) says: "Je ne doute pas que ces métis ne soient féconds, et qu'ils ne remontent à la race de la mère (collared turtle) dans la suite des générations."

"Schwenckfeld has described one of these mules under the name *Turtur mixtus*,²⁸ produced from a male Common Turtle and a female Collared turtle.²⁹ These birds are seldom reared except for the charm of their plumage, although the young are easily fattened and their flesh is quite tender.

" . . . Temminck makes a separate species of this bird (the White Turtle, *C. vencris*) which he calls the White Blond Turtle³⁰ but other naturalists regard it only as a constant variety or race of the preceding species; and this seems to us all the more probable, as the offspring which it produces with that species are always fertile, while those which it produced with the Wood Turtle are always mules.

"I have given this charming variety the name, 'Dove of Venus', because it is usually with these birds that painters and poets represent the mother of love. This Turtle is a little smaller than the preceding. Its plumage is white; the collar is wanting, but it is indicated on the back of the neck by feathers more rigid than the others, and of a little duller white. This bird is more delicate than the preceding and requires greater care and especially more heat. Its habits and manners are precisely the same.

"It is easily mated with the Collared Turtle; but the young that are raised vary but little in plumage. They are almost always exactly like the Collared Turtle, or the White Turtle, and in the latter case they never have a black collar. This is a peculiarity which never occurs in the pigeons, the young of which may take after the father and the mother, while in the Turtles they are always wholly one or wholly the other, although we may find in the same brood one white and one gray." (H 6)

I find the pure white ring-dove (*St. alba*) is distinguished from the blond ring-dove (*St. risoria*) in the following ways: (1) it is pure white; (2) it is smaller than the blond ring and has a shorter tail; (3) the young are hatched quite naked, i.e., they have almost no "down"; (4) the voice is quite distinct, though evidently of

²⁸ Schwenckfeld. *Avi. Sil. Therio-tropheum Silesiae, etc.*, 1603. (Buffon, *loc. cit.* p. 551, also cites this case).

²⁹ In the chapter devoted to the common turtle of Europe (*Turtur turtur*) Boitard and Corbié have the following to say of the cross between it and the ring-dove:

"It may be mated with the Collared Turtle and even with the White Turtle; but the offspring resulting are sterile—at least only such have hitherto been obtained. The hybrids mate among themselves, or with the Collared Turtle, or with the Wood Turtle; they caress each other with the same ardor, lay and cover their eggs with the same solicitude, and yet these eggs never hatch—without doubt the fault of the germ. This experiment, made by Manduyt, and by Vieillot, and with a sort of stubborn persistency by my collaborator, Mr. Corbié, has always had the same result."

Manduyt relates his experience in crossing in the *Encyclopédie Méthodique*, 1784, p. 482. Speaking of the Common, or Wood Turtle, as he called it, he says: "It will breed equally well, whether crossed with the Collared Turtle, as Schwenckfeld has done, or with the White Turtle, as I have done; but so far from the trial which I have made tending to prove that the hybrids arising from these crosses are fertile, they furnish no proof, but evidence to the contrary."

"Having inclosed a male wood Turtle and a White Turtle (*Turtur alba*) in the same aviary, the two birds soon mated; the female laid, the eggs hatched, the young resembled the father more than the mother, the plumage of the latter only having lightened up that of the male, without destroying the imprint of the half collar borne by the father on each side of the neck. The hybrids were of a very agreeable shade of light grey (gris-blanc). There were several sets of eggs from these birds, all developed successfully, and all the young were raised. They were partly males, partly females, as was evident from the fact that some had much stronger voices than the rest. The positive proof that some were females was furnished by their laying eggs. I separated them, and made sure after sufficient time that those which I regarded as males did not lay. I kept a male and a female inclosed for more than a year without their having mated, and yet the female laid twice, two eggs each time, without making any nest, and without taking any care of the eggs, which she allowed to escape wherever she happened to feel the need of getting rid of them. I inclosed this same female with the male by which she was sired, and which was eager to mate. They passed a summer together in the same aviary, the male kept up his addresses to the female unceasingly, but she never responded to his desires, or to any of his caresses, but appeared absolutely indifferent to them; and yet she laid several times, as when she was inclosed with a male hybrid, and always without taking any care of her eggs, which I found several times in the vessel which served to hold the drinking water for the pair kept in captivity.

"I removed the first female and gave to the same male another, likewise a hybrid; the result of the experiment was the same. These hybrids, then, were not fertile *inter se*, nor were the females fertile with the male parent; but it would be necessary to repeat the test upon a much larger number of individuals in order to be able to decide."

³⁰ An error. Temminck gave this name to *albinos* of the blond turtle, and regarded the white turtle as a pure breed or species.

the same general character; (5) the ring is cream-colored, just distinguishable from the general white of the rest of the body; (6) the white rings always prefer their own kind to the blond rings in mating, and the latter also prefer their own kind; (7) in crossing, the young tend strongly to preserve the original colors, either brown or white. It is true that the incubation periods of their eggs is the same, and further that most of their habits are quite similar. The white rings are less resistant to trying conditions and probably have a shorter term of life.

The general color of the blond ring (*St. risoria*) could be described as a pale fawn or isabelline, which becomes lighter on the throat, and fades out towards and around the vent, passing imperceptibly into the white of the under tail-coverts.

The black ring or collar is sometimes narrower at its middle on the back of the neck than at the ends. This fact, together with the complete interruption of the ring on the back of the neck in the first plumage, by which it is broken into two portions, one on each side of the neck, beginning a little below and behind the ear-coverts and growing narrower backward, suggests that the half ring has arisen by the extension of two spots like those seen in the mourning-dove. This ring is creamy white in the white ring. It is often reduced to a mere shadow, or wholly absent, in the first plumage.

THE JAPANESE RING-DOVE (STREPTOPELIA DOURACA).

This bird is not *St. risoria*, although it looks like it; it has a different voice, never laughs, coos rarely, lays sparingly, is larger than *St. risoria*, and is somewhat darker. These facts I have been able to learn definitely from keeping and breeding in confinement 24 birds received from Japan.³¹

Stejneger³² gives this dove the name *Turtur douraca torquatus* (ringed turtle-dove = Shirako-bato). Hodgson³³ is responsible for the name *douraca*, a name which Stejneger thinks should be reserved for the wild ring-dove of India; and Bogdanow³⁴ is held responsible for *torquatus*, since Brisson had before (1760) given this name to the common tame ring-dove.

Stejneger is responsible for using both names as a means of separating the Chinese and Japanese birds (*torquatus*) from the Indian type (*douraca*).

Stejneger says Schlegel (Mus. P. Bas, Columb., p. 123, 1873) made it clear that the tame bird is not a descendant of the wild ring-dove of India, China, or Japan.

Stejneger insists that the Indian species is distinct, as the outer web of the outer tail-feathers in *T. risoriis* is white, while it is blackish in *T. douraca*. The Indian bird is, moreover, darker (drab).

If this species is distinct from the wild Indian ring-dove, as Bogdanow and Stejneger claim, then I should prefer *Turtur torquatus* to the trinomial proposed by Stejneger. Schlegel also (see Stejneger, loc. cit., p. 427) calls attention to the racial difference between the Indian species (*douraca*) and the form found in China and Japan. This difference is thus stated by Stejneger (p. 427):

"My Japanese specimens, as well as a number of Corean examples, which Mr. Jouy kindly allowed me to examine, have the color of the back nearly that of Ridgway's 'Isabella

³¹ Through the kindness of Professor Iijima.

³² Proc. U. S. Nat. Mus., June, 1887, p. 426.

³³ Gray's Zool. Misc., p. 85.

³⁴ Tr. Sib. Obtsch. Jestestv., XII, p. 98, 1881.

color' (Nomencl. Colors, pl. III, No. 23), while the Indian bird has the back duller and darker, or like his 'drab' (pl. III, No. 18). The latter, which is the true *T. douraca*, seems also to be somewhat smaller.³⁵

This difference in color seems to me of doubtful value as a basis for distinguishing species, since in the ring-doves, as in the turtle-doves proper, and indeed in most if not all species of pigeons, we meet with a similar difference—the "lighter" and the "darker" shades often quite marked.

The difference in "size," based on a single Indian bird skin, is of no value, unless it be shown to be general. Salvadori (*loc. cit.*, p. 432) gives the following measurements of *T. douraca* (including Chinese and Japanese forms): Total length 11.9 in.; wing 6.8 in.; tail 5; bill 1.6; tarsus 0.9. The wing measurement is 172 mm. (6.8 in.) Stejneger's specimen of *T. douraca* measured only 160 mm.—evidently an unusually small bird, or a poorly preserved skin.³⁶

Stejneger points out as a striking constant distinction between *T. risorius* and *T. douraca*, that the outer web of the outer tail-feathers in *T. risorius* is "entirely white," while in *T. douraca* it is "blackish." Further, the tail is longer in the latter.

I find this color distinction is overdrawn. Examining two female *St. risoria*, I find that in neither case is the web "entirely white."

Comparing these with a female Japanese ring-dove, I find that in the latter the outer web starts at the base as a *light pearl gray*, *lighter* (more whitish) *at the outer edge*, becomes gradually darker gray until, at about the middle, the blackish appears (the edge continuing whitish) and continues for about 32 mm., or for about the third quarter of the entire feather-length, lightening up into paler and paler gray towards the tip.

In the first *St. risoria* female I find as follows: The outer web starts at the base as a light pearl-gray—lighter at the outer edge—and darkens into a clear gray, which for the first third of the length is not distinguishable from that of the above Japanese bird; but towards the middle the gray becomes paler (just where the blackish prevails in the Japanese) and becomes pure white only in the terminal fifth.

The second *St. risoria* differs from the first in having the gray a shade paler and the light edge wider. But the edge is not pure white, and it shades into the gray of the mesial half. The real distinction, then, is that the Japanese ring has black in a portion of the outer web—*i.e.*, has a darker web as a whole³⁶—but the inner web also has a larger and deeper extent of black. This greater amount of black in the tail is correlated with the darker color of the Japanese bird as a whole.

The midrib, curiously, is decidedly darker in *St. risoria* than in the Japanese bird. The tail-feathers are from 12 mm. to 18 mm. longer in the Japanese birds than in the blond rings.

In all three of the birds just compared the black is stronger and more sharply limited in the under side of the feathers than above. In the Japanese ring-dove it reaches nearer to the tip than in the blond rings, and is continued on the outer web beyond its limit on the inner web by at least 12 mm. The wing of the above-mentioned Japanese ring-dove measured 162 mm.

³⁵ Schlegel (*loc. cit.*) points out that *T. risorius* differs from *T. douraca* of India in having: (1) a shorter tail; (2) the outer web of the outermost tail feathers *white*; (3) a very decidedly different voice.

³⁶ Salvadori (p. 432) says of *T. douraca*: "Lateral tail-feathers leaden grey, fading gradually into white towards the tips." Notice that he says nothing of "blackish."

Stejneger's wing measurements of two Japanese ring-doves are 176 mm. for a male and 174 mm. for a female. For one female of the true Indian ring-dove, Stejneger found a wing-length of 160 mm. It will be seen that my Japanese ring with a wing of 162 mm. is nearly the same as Stejneger's Indian ring-dove. This shows that the Japanese birds certainly sometimes attain only the length given for *T. douraca*, and hence Stejneger's size distinction of the Japanese and Indian birds is probably of no value. I call the Japanese ring-doves *Streptopelia douraca*. (H 14)

RECENT DESCRIPTIONS OF RING-DOVES.

Mr. J. H. Newman³⁷ has recently undertaken to give the names and affinities of the ring-doves (which he calls "collared turtle-doves") of Asia, Burma, and India. The names considered are:

- decaocta* (given by) Frivaldszky, 1838, to the Balkan species.
- douraca*, Hodgson, 1844, to the Nepal or Indian species.
- xanthocylus*, Newman, 1906, to the Burmese subspecies.
- torquatus*,³⁸ Bogdanow, 1881, to the Chinese and Japanese species.
- douraca torquatus*, Stejneger (1887), to Chinese and Japanese species.
- decaocta decaocta*, Newman (1906), to Balkan, or "the North-eastern" species.

Newman states that the Indian species has very generally been confounded with *T. risoria* and regarded as the "typical form." He claims that the "type" is represented in the "big north-eastern race," namely, that of the Balkans to Turkestan. The Balkan type differs from the Indian species in being "much larger; having a broader nuchal collar; in being more conspicuously edged above and below with white; more white on the outer tail-feathers; and in having the secondaries and their coverts a pale pearl gray."

Although these are all variable features, Mr. Newman thinks that taken together they differentiate the two forms.

The names introduced by Newman require consideration. In order to maintain the contention stated above, he makes use of trinomials for each of the three species as follows: For the Balkan species, *Turtur decaocta decaocta*; for the Indian species, *Turtur decaocta douraca*; for the Burmese species, *Turtur decaocta xanthocylus* n. subsp. Mr. Newman introduces the name *xanthocylus* for the Burmese variety or subspecies, and gets the other names from older writers.

In regard to the name of the Balkan (or Asiatic) species, it is noted that Von Othmar Reiser, in his "Avifauna of the Balkans" (1894), cites a work by Johann von Frivaldszky, entitled "Balkányi Természettudományi Utazásról, Budan," (1838), in which is figured and described a dove of this species. Frivaldszky's work is little known and has usually been overlooked, but the name he gives—*Columba decaocta*—is the oldest one known for this species, as Linnaeus's name, *C. risoria* (1766), refers to the domestic species.

Frivaldszky founded his name on the dove from the Balkan regions (The Balkans through Turkestan, as far as Yarkand). Hume, in "Stray Feathers" (1874, II, p. 519), evidently not knowing Frivaldszky's work, named the same species *Turtur stoliczkae*.³⁹

³⁷ Avicultural Magazine, Vol. IV, No. 11, Sept. 1906.

³⁸ Bogdanow adopts the name from Brisson (Orn., I, p. 92). Stejneger (1887) rejects Brisson according to the A. O. U. code, and then makes Bogdanow responsible for the name, which he (Stejneger) applies to the Chinese-Japanese species to distinguish it from the Indian species, the true *T. douraca*. A remarkable respect with disrespect for priority.

³⁹ Mr. Dresser published these facts in Ibis, 1903, pp. 89, 90.

The Indian species is held to be a subspecies of the Balkan or Asiatic species (*T. decaocto*), and for this subspecies Newman proposes to use Hodgson's name "douraca," which was founded on a dove from Dhoturakha.⁴⁰ Hodgson's name, according to Salvadori, applies to all the ring-doves in Japan, China, Burma, India, and the Balkans, except *T. humilis* and its Indian relative *T. tranguebaricus*.

Newman states that the Burnese species (*xanthocylus*) is easily distinguished by its "broad yellow bare rings round the eyes." He further claims, with Shelley, that *T. risorius* (Barbary dove) is derived from the "rose-grey turtle dove (*T. riscogriscus*) of North-eastern Africa."

At this date (September 1906) it seems that the number of species of ring-doves is not definitely settled. The following are fairly well determined: The common ring-dove (*St. risoria*) goes (in a group?—EDITOR) with the African species *St. riscogriscus*. The Balkan ring-dove (*St. decaocto*), Indian ring-dove (*St. douraea*), Oriental ring-dove (*St. torquatus*),⁴¹ and Chinese-Japanese make one group.

Thirteen species (besides *risoria*) are described by Salvadori (pp. 414–438). The additional ones noted here indicate 17 species for the genus *Streptopelia*. There are 14 species of gray to blond color, 1 species of white color,⁴² 2 species of red or ruddy color. (H 6)

⁴⁰ A place conjectured by Newman to be in Nepal, a country on the southern slope of the Himalaya system. Hodgson's specimens were from Nepal, according to Salvadori. (See Hodgson in Gray's Zool. Misc. p. 85, 1844.)

⁴¹ At this later date the author seems definitely to agree to the separation of the Indian and Japanese forms. Throughout this volume, however, the name *douraea* applies to the Japanese ring-doves.—EDITOR.

⁴² This statement, too, indicates that Professor Whitman regarded *St. alba* as a good species.—EDITOR. (W 10 and WW 2)

CHAPTER XVI.

INFLUENCE OF THE SPERMATOZOA OF PIGEONS ON RATE OF DEVELOPMENT OF THE EMBRYO.¹

Crosses of those species of pigeons which have unequal periods of incubation offer opportunities for the study of the separate influence of egg and sperm upon the rate of development of the embryo which they conjointly produce. In other words, such crosses give opportunity for the study of such a question as this: When a cross is made between a female pigeon of a species whose incubation period is 14 days and a male whose species requires 18 days, will the incubation period of an egg from such a pair be prolonged? If so, is the prolongation due to the influence of the male?

TABLE 178.—*Normal incubation time of domestic pigeons.*

PAIR I.—♂ common (1) × ♀ common (1), 1897.			
Eggs.	Laid.	Hatched	Incubation. ²
A 1	5 ^b 15 ^m p.m. Feb. 28.....	10 ^b 08 ^m a.m. Mar. 20.....	19 das. 16 hrs. 53 m.
A 2	5 ^b 30 ^m p.m. Mar. 2.....	6 ^b 35 ^m a.m. Mar. 20.....	17 das. 13 hrs. 5 m.
C 1	5 ^b 00 ^m to 5 ^b 40 ^m p.m. Apr. 14....	3 ^b 20 ^m p.m. May 2.....	17 das. [21 hrs. 40 m. to 22 hrs. 20 m.]
C 2	4 ^b 35 ^m p.m. Apr. 16.....	7 ^b 08 ^m a.m. May 3.....	16 das. 14 hrs. 33 m.
D 1	p.m. May 14.....	1 ^b 40 ^m p.m. June 2.....	18 das. 20 to 21 hrs.
D 2	p.m. May 16.....	6 ^b 20 ^m a.m. June 2.....	16 das. 13 to 14 hrs.
G 1	p.m. Aug. 10.....	5 to 6 a.m. Aug. 29.....	18 das. 12 hrs., nearly.
G 2	p.m. Aug. 12.....	12 to 1 p.m. Aug. 29.....	16 das. 18 hrs., nearly.

PAIR II.—♂ common (1) × ♀ common (A 1), 1898.			
B 1	B 2	C 1	C 2
p.m. Jan. 4.....		No development.	
p.m. Jan. 6.....		12 m. Jan. 23.....	16 to 17 das.

PAIR III.—♂ Satinette and ♀ Satinette, 1898.			
C 1	C 2	D 1	D 2
4 ^b 05 ^m p.m. Mar. 22.....	7 to 8 a.m. Apr. 10.....	18 das. 15 to 16 hrs.	
2 ^b 30 ^m to 3 ^b 30 ^m p.m. Mar. 24.....	1 to 2 p.m. Apr. 10.....	16 das. 21 ¹ ₂ to 23 ¹ ₂ hrs. (A 15)	

¹ In this and succeeding tables the time determinations of much reliability and accuracy are set in special type.—EDITOR.

This subject has interested me for some time past, but for the present purpose I have just had time to collect the data, and I give them without having had much time to reflect upon them. My study of the subject is not yet concluded.² In this investigation it is necessary to learn the normal incubation time of the species used in the crosses and then the incubation period for the germs which represent the cross. In the common dove (*Columba domestica*) the result of all the tests I have made till now justify me in placing the incubation period for the first egg of the clutch at 18 days and for the second egg at 17 days (table 178). In determining the

¹ Stenographic report (slightly corrected by the author and adapted by the editor) of a lecture to the Zoological Club, The University of Chicago, March 9, 1898.

² The results of later studies have been incorporated in this chapter.—EDITOR.

duration of incubation one meets with the difficulty that the incubation for the second egg is not the same as that for the first. All doves have the habit of "half-sitting" on the first egg during the first day; sometimes they will even leave it uncovered during the first night. As a rule the parents stand over the egg with feathers just touching it, keeping it a little warm, but not as thoroughly warm as if the bird sat closely. After the second egg is laid doves begin to sit steadily and closely, leaving it rarely and for only very short periods.

The incubation time for the first egg in the ring-dove (*Streptopelia risoria*) is 15 days, plus or minus a few hours; for the second egg the period is 14 days minus, or, in rare cases, plus a few hours. The incubation periods of the common dove and the ring-dove differ therefore by about 3 days. What happens if we take a male with a longer incubation period and a female with a shorter period? Do the eggs hatch earlier or later? My first impressions in regard to this matter were that the egg always developed according to its normal rate, no matter what male united with the female; the egg seemed to follow only its own regular period. But in order to decide the matter the value of a few hours of difference must be made certain and the various necessary conditions and crosses considered. I have looked at the various difficulties, and it has seemed to me necessary not only to follow up the common doves and ring-doves, making sure of the normal period of incubation of the two species, but also to follow up very closely the crossed birds, noting the nature and constancy of incubation. It is also further necessary to make the crosses in both directions, and if possible at exactly the same season. I have had thus far but two cases³ from the crossing with the male ring-dove, so that there my observations can not be considered conclusive; they do seem, however, to be of interest.

TABLE 179.—Incubation time of eggs of ring-dove fertilized by common pigeons.

Pairs.	Eggs.	Laid.	Hatched.	Incubation.
♂ White fantail (FB) . .	A 1	4 ^h 58 ^m p.m. Apr. 17, 1897.	No development.	
♀ Ring-dove	A 2	7 ^h 43 ^m a.m. Apr. 19, 1897.	7 ^h 30 ^m May 4.....	15 das. less 13 m.
♂ Homer (Hom 1) . .	A 1	4 ^h 45 ^m p.m. Mar. 11.....	12 noon Mar. 27.....	15 das. 19 hrs. 15 m.
	A 2	9 ^h 16 ^m a.m. Mar. 13.....	5 to 6 a.m. Mar. 28.....	14 das. 20 to 21 hrs.
♂ Homer (Hom 1) . .	C 1	5 ^h 29 ^m p.m. Apr. 30.....	6 ^h 05 ^m a.m. May 16.....	15 das. 12 hrs. 36 m.
♀ Ring-dove (M 2)	C 2	9 ^h 10 ^m a.m. May 2.....	5 to 6 a.m. May 17.....	14 das. 20 to 21 hrs.
♂ Homer (1) . .	A 1	4 ^h 39 ^m p.m. June 5.....	5 ^h 30 ^m a.m. June 21.....	15 das. 13 hrs.
	A 2	7 ^h 55 ^m a.m. June 7.....	6 ^h 00 ^m p.m. June 21 ¹	14 das. 10 hrs.
♂ Homer (1) . .	C 1	6 ^h 50 ^m p.m. Aug. 13.....	5 to 6 a.m. Aug. 29.....	15 das. 11 hrs.
♀ Ring-dove (F) . .	C 2	8 ^h 45 ^m a.m. Aug. 15.....	Failed.	
Common dove (Wh) . .	D	4 ^h 05 ^m p.m. Sept. 5.....	12 ^h 30 ^m p.m. Sept. 20.....	14 das. 20 hrs. 25 m.
♀ Ring dove (D 2) . .	C 1	4 to 6 p.m. Jan. 12, 1898.	Failed.	
	C 2	7 to 9 a.m. Jan. 14.....	6 ^h 00 ^m to 6 ^h 30 ^m a.m. Jan. 29.	14 das. 20 to 22 hrs. (A 15)

¹ This egg was opened; it would have hatched next morning.

In the cross of the ring-dove female and the common dove male, the incubation period of the first egg is 15 days plus a number of hours; for the second egg it is 14 days plus a number of hours (see tables 179, 180, 181, and 182). This rather closely approaches the normal, the normal being 15 days plus or minus for the first and 14 days minus or plus for the second (see tables 183 and 185). The result all hangs on

a certain number of hours. The male has not very much prolonged the period of incubation, but before I can say he has not affected it I have to consider the facts to be learned from the reciprocal cross, from crosses made simultaneously, if possible, and from crosses of still other species.

TABLE 180.—Incubation period of ♂ archangel (*Ar I*) × ♀ ring-doves (*D 1* and *D 2*).

Eggs.	Laid. ¹	Hatched.	Incubation.	Remarks. ¹
A 1	4 ^h 00 ^m to 4 ^h 30 ^m p.m. Feb. 18, 1897	11 to 12 a.m. Mar. 6.	15 das. 19 to 20 hrs.	Interval, 1 da. 17 hrs. 29 m
A 2	9 ^h 29 ^m a.m. Feb. 20, 1897	Thin shell.....	Not tested.	nearly.
B 1	4 ^h 55 ^m p.m. Mar. 14.....	No development.....	.....	.....
B 2	10 ^h 30 ^m a.m. Mar. 17.....	Developed, died.....	.....	Interval, 1 da. 17 hrs. 35 m.
C 1	5 ^h 18 ^m p.m. Apr. 6.....	No development.....	.....	{ Interval not certain; C 1
C 2	a.m. Apr. 8.....	No development.....	.....	{ laid 5 days after removal of eggs.
D 1	6 ^h 12 ^m p.m. Apr. 29.....	No development.....	.....	.....
D 2	a.m. May 1.....		.....	D 1 laid 5 days after removal of eggs.
E 1	5 ^h 26 ^m p.m. May 11.....	No development.....	.....	.....
E 2	8 ^h 45 ^m a.m. May 13.....		.....	E 1 laid 6 days after removal of eggs. Interval, 1 da. 15 hrs. 19 m.
F 1	5 ^h 27 ^m p.m. June 6.....	No development.....	.....	.....
F 2	8 ^h 57 ^m a.m. June 8.....		.....	Interval, 1 da. 15 hrs. 30 m
G 1	5 ^h 37 ^m p.m. June 26.....	No development.....	.....	.....
G 2	9 ^h 11 ^m a.m. June 28.....		.....	Interval, 1 da. 15 hrs. 34 m
H 1	5 to 6 p.m. July 12.....	No development.....	.....	.....
H 2	a.m. July 14.....		.....	.....
I 1	5 ^h 48 ^m p.m. Aug. 2.....	9 to 1 p.m. Aug. 18.....	15 das. 16 to 20 hrs	Interval, 1 da. 14 hrs. 49 m.
I 2	8 ^h 37 ^m a.m. Aug. 4.....		Pricked shell, failed.....	.....
J 1	5 ^h 34 ^m p.m. Aug. 29.....	No development.....	.....	Interval, 1 da. 15 hrs. 16 m
J 2	8 ^h 50 ^m a.m. Aug. 31.....		.....	.....
A 1	3 ^h 47 ^m p.m. Jan. 28, 1898.....	Developed, died.....	.....	Eggs by second ♀ (D 2).
A 2	a.m. Jan. 30, 1898.....	No development.....	.....	.....
B 1	p.m. Feb. 19.....	Pricked shell, failed.....	.....	Eggs by second ♀ (D 2).
B 2	a.m. Feb. 21.....	No development.....	.....	(A 15)

Summary: Time, Feb. 18, 1897, to Mar. 1898. Of 24 eggs, 2 hatched, 6 fertilized; none reared.

¹ Some data referred to in various chapters of Vol. III are presented in connection with this and succeeding tables.—EDITOR.

TABLE 181.—Incubation period of ♂ black Japanese tumbler (*T 3*) × ♀ ring-dove (*L. 1*).

Eggs.	Laid.	Hatched.	Incubation.
A 1	5 p.m. July 23, 1897.....	No development.....	.....
A 2	7 to 9 a.m. July 25, 1897.....	1 to 2 p.m. Aug. 8.....	14 das. 4 to 7 hrs.
B 1	4 to 6 p.m. Aug. 25.....	5 to 6 a.m. Sept. 10.....	15 das. 11 to 14 hrs.
B 2	8 a.m. Aug. 27.....	Developed, did not hatch.....	.....
C 1	p.m. Sept. 26.....	Lost.....	.....
C 2	a.m. Sept. 28.....	.....	.....
D 1	Time not noted; about Oct. 9.....	No development.....	.....
D 2		.....	.....
E 1	4 ^h 08 ^m p.m. Oct. 21.....	12 noon, Sat. Nov. 6.....	15 das. 20 hrs.
E 2	a.m. Oct. 23.....	No development.....	.....
F 1	3 ^h 36 ^m p.m. Dec. 13.....	7 a.m. Dec. 30.....	16 das. 15 hrs. ¹
F 2	8 to 9 a.m. Dec. 15.....	6 a.m. Dec. 30.....	14 das. 21 to 22 hrs.
G 1	4 to 6 p.m. Jan. 20.....	Pricked shell, failed.....	.....
G 2	7 to 9 a.m. Jan. 22.....	a.m. Feb. 6.....	14 das. 20 to 22 hrs.
H 1	5 p.m. Feb. 19.....	12 to 1 Mar. 7.....	15 das. 19 to 20 hrs.
H 2	a.m. Feb. 21.....	Pricked shell, failed.....	.....

Summary: Time, July 1897, to March 1898; 16 eggs; reared 5, hatched 7, 10 fertilized.

(A 15)

¹ Hatched only with help and soon died; the hatching was abnormally delayed, perhaps from imperfect development.

The results of two such reciprocal crosses incubated simultaneously, and with the eggs of the crossed birds interchanged with uncrossed birds for incubation purposes, may be found in table 185. It is there indicated that the sperm of the male tumbler added 7 to 24 hours to the incubation period.

Eggs from a further cross between a male ring-dove and a female homer were incubated simultaneously with eggs from three pairs of common pigeons. The result, as seen in table 186, indicated a shortening of the period by about 8 to 26 hours as a result of fertilization by the ring-dove male.

I have studied the incubation period of the eggs of the wild passenger-pigeon (*Ectopistes migratorius*) and have also obtained data on the length of this period

TABLE 182.—Incubation time of ♂ common dove (*Z*) ♀ ring-dove (*D 2*).

Eggs.	Laid.	Hatched.	Incubation.
A 1	4 to 6 p.m. May 3, 1896 . . .	No development.	
A 2	8 to 9 a.m. May 5, 1896 . . .	No development.	
B 1	4 to 6 p.m. May 23	11 to 12 a.m. June 8	15 das. 18 to 19 hrs.
B 2	8 ^b 50 ^m a.m. May 25	Developed, did not hatch.	
C 1	5 to 6 p.m. June 19	No development.	
C 2	9 ^b 53 ^m a.m. June 21	No development.	
D 1	p.m. July 1	No development.	
D 2	a. m. July 3	No development.	
E 1	5 ^b 30 ^m p.m. July 20	No development	Removed July 28.
E 2	8 ^b 30 ^m to 8 ^b 45 ^m a.m. July 22	No development.	
F 1	5 ^b 30 ^m to 6 p.m. Aug. 2	Developed to about a week.	
F 2	7 to 9 a.m. Aug. 4	No development.	
G 1	4 to 5 p.m. Aug. 24	No development.	
G 2	8 to 9 a.m. Aug. 26	No development.	
H	3 ^b 50 ^m p.m. Sept. 11	No development.	
I 1	4 to 4 ^b 45 ^m p.m. Oct. 11	No development.	
I 2	8 ^b 47 ^m a.m. Oct. 13	No development.	
J 1	4 to 5 p.m. Oct. 31	No development.	
J 2	8 ^b 55 ^m a.m. Nov. 2	12 noon Nov. 17	15 das. 3 hrs. (long for 2d egg).
K 1	4 to 5 p.m. Nov. 30	Developed to one week.	
K 2	9 ^b 16 ^m a.m. Dec. 2	No development.	
L 1	4 to 6 p.m. Dec. 20	Before 6 a.m. Jan. 5, 1897	15 das. 12 to 13 hrs.
L 2	9 ^b 20 ^m a.m. Dec. 22	No development.	
M 1	5 ^b 05 ^m p.m. Jan. 23	No development.	
M 2	10 ^b 05 ^m Jan. 25, 1897	Before 6 a.m. Feb. 9 . . .	14 das. 18 to 20 hrs.
N 1	5 ^b 04 ^m p.m. Feb. 26	Developed for week only.	
N 2	9 ^b 28 ^m a.m.	Developed but killed.	
O 1	4 ^b 42 ^m p.m. Mar. 19	5 to 6 a.m. Apr. 4	15 das. 12 to 13 hrs.
O 2	9 ^b 16 ^m a.m. Mar. 21	No development.	
P 1	4 to 6 p.m. Apr. 17	Developed but stopped.	
P 2	7 ^b 50 ^m a.m. Apr. 19	Developed but stopped.	
Q 1	5 ^b 53 ^m p.m. May 16	No development.	
Q 2	a.m. May 18		
R 1	5 ^b 08 ^m p.m. May 30	No development.	
R 2	7 ^b 50 ^m a.m. June 1	Developed, failed.	
S 1	6 ^b 21 ^m p.m. June 20	Developed, failed.	
S 2	8 ^b 53 ^m a.m. June 22	No development.	
T 1	5 to 6 p.m. July 12	5 to 6 a.m. July 28	15 das. 11 to 13 hrs.
T 2	7 to 9 a.m. July 14	5 to 6 a.m. July 29	14 das. 20 to 23 hrs.
U 1	4 to 7 p.m. Aug. 22	No development.	
U 2	Premature	Not tested.	

(A 15)

Time: May 3, 1896, to Aug. 22, 1897; 41 eggs; raised 4 males; 7 hatched; 16 fertilized.

when the passenger male was crossed with ring-dove females. This pigeon has the shortest incubation period known among doves and pigeons. The period is here a little less than 13 days; it averages about $12\frac{1}{2}$ days (see table 187). This is a shorter period than that of the ring-dove, in which, as we have seen, the period is 14 to 15 days. The passenger-pigeon's incubation time is nearly as much short of that of the ring-dove as the period of the latter is short of the common pigeon. What is the effect on the incubation time of uniting the male passenger-pigeon and the female ring-dove? The answer from our data is as follows: For the first egg the period is 14 days plus 20 hours; for the second 13 days plus 6 to 20 hours (see tables 188 and 189). These figures come close to the normal range for the ring-dove; still I can not help feeling that there is some influence, however small, exercised by the male on the rate of development. Comparing the results obtained with the passenger-pigeon and the common pigeon, when each of these mated to the ring-dove, we find these give us the two extremes. In a condensed form these two crosses may be stated to stand as follows: Common pigeon male \times ring-dove female: first egg, 15 days plus; second egg, 14 days plus. Passenger-pigeon male \times ring dove female: first egg, 14 days plus 20 hours; second egg, 13 days plus 6 to 20 hours. Females of the same species (*St. risoria*) are used in both cases; different males are given. One of these males represents an incubation period of about $12\frac{1}{2}$ days, the other a period of 17 to 18 days. The difference in the result is small, but it is enough to indicate that there is a small though measurable influence of the male on the rate of development. (A more complete summary of these crosses of ring with domestic and passenger-pigeons is given in table 190.—EDITOR.)

The red ring-dove of Japan (*Streptopelia humilis*) has also a short incubation period. This dove, too, has been crossed with the ring-dove, with the result made clear by table 191. The males of this species, too, shortened the period of development in the egg of the ring by from 12 to 24 hours. The three incubations bearing on this point were made simultaneously.⁴

The effect⁵ of the sperm of one species on the rate of development of the eggs of another species was observed in many isolated instances with several different crosses. Some of these have been referred to in connection with the tabulated breeding records. Two cases may be added here.

In the cross of the female wood-pigeon (*Columba palumbus*) with a male common pigeon "about one day" was added to the incubation period; this was found in two cases. (A 14) Another series of matings supplied data for a reciprocal cross. In a female *Columba guinea*, whose normal period is 16 days plus 12 hours for the first egg and 15 days plus 16 to 18 hours (XS 3) for the second, the period became 17 days plus 12 hours for the first egg when mated with a *C. domestica*. In the reverse cross a male *C. guinea* shortened by $1\frac{1}{2}$ days the time of hatching of an egg of a homer, the period becoming 16 days plus 20 to 22 hours. "This time is $1\frac{1}{2}$ days shorter than in homers and common pigeons and again is a proof that the male influences the rate or speed of development."⁶ (G 3)

⁴ Nearly all of the data for the preceding parts of this manuscript were obtained from original data catalogued as A 111, A 15, A 16, and R 18.—EDITOR.

⁵ The concluding paragraphs were written by the editor.

⁶ There is reason to believe that there are many phenomena of inheritance in hybrids—particularly the differences of reciprocal hybrids—which will, at some time, be found to be based essentially upon the "different rates of development" of the forms crossed. If so, such phenomena should perhaps be more easily discovered and analyzed in crosses of annual with biennial plants; but they are probably also discoverable in animal crosses.—EDITOR.

TABLE 183.—Normal incubation time of ring-doves ($\sigma A \times \varphi A$).

Eggs.	Laid.	Hatched.	Incubation.
J 1	4 to 6 p.m. Mar. 12, 1895.....	12 to 6 p.m. Mar. 28.....	15 das. 18 to 20 hrs.
J 2	8 to 9 a.m. Mar. 14.....	12 to 6 p.m. Mar. 28.....	14 das. less 4 hrs. at least.
K 1	4 to 5 p.m. Apr. 15.....	5 to 7 a.m. Apr. 30.....	14 das. 15 to 17 hrs.
K 2	8 ^b 38 ^m a.m. Apr. 17.....	Opened.	
L 1	5 ^b 15 ^m to 5 ^b 45 ^m p.m. May 13.....	5 to 7 a.m. May 28.....	14 das. 12 hrs. nearly.
L 2	8 to 8 ^b 30 ^m a.m. May 15.....	5 to 7 a.m. May 29.....	14 das. less 4 hrs., at least.
M 1	4 ^b 46 ^m p.m. June 18.....	a.m. July 4.....	15 das. 12 to 14 hrs.
M 2	8 to 8 ^b 45 ^m a.m. June 20.....	a.m. July 5.....	14 das. 20 to 22 hrs.
N 1	4 ^b 35 ^m p.m. July 25.....	5 to 6 a.m. Aug. 9.....	14 das. 12 to 13 hrs.
N 2	7 ^b 36 ^m a.m. July 27.....	12 ^b 30 ^m p.m. Aug. 10.....	14 das. 5 hrs.
O	4 ^b 40 ^m p.m. Aug. 31.....	Sept. 16.....	(?)
P 1	4 to 6 p.m. Oct. 15.....	10 a.m. Oct. 31.....	15 das. 20 hrs. nearly.
P 2	8 to 9 a.m. Oct. 17.....	2 p.m. Oct. 31.....	14 das. 5 to 6 hrs.
Q 1	3 ^b 30 ^m to 5 ^b 30 ^m p.m. Dec. 21.....	12 to 3 ^b 30 ^m p.m. Jan. 6, 1896.....	15 das. 8 to 12 hrs.
Q 2	9 ^b 20 ^m a.m. Dec. 23.....	2 p.m. Jan. 6, 1896.....	14 das. 3 hrs. 40 m. (A 15)

TABLE 184.—Incubation time of eggs of σ^a alba \times risoria (ring) \times φ homer.

Eggs.	Laid.	Hatched.	Incubation.	Remarks.
A 1	p.m. June 16, 1897.....	No development.....		
A 2	p.m. June 18.....	No development.....		Removed after 4 or 5 days.
B 1	p.m. June 28.....	Development began; egg lost		
B 2	p.m. June 30.....	No development.		
C 1	6 p.m. July 13.....	No development.		
C 2	p.m. July 15.....	No development.		
D 1	5 to 6 p.m. July 29.....	No development.		
D 2	Before 4 p.m. July 31.....	No development.		
E 1	p.m. Aug. 12.....	No development.		
E 2	p.m. Aug. 14.....	No development.		
F 1	5 ^b 37 ^m p.m. Aug. 29.....	Developed only for a week or 10 days, then failed.		
F 2	p.m. Aug. 31.....	No development.		
G 1	5 ^b 20 ^m p.m. Oct. 7.....	No development.		
G 2	p.m. Oct. 9.....	No development.		
H 1	5 ^b 18 ^m p.m. Oct. 23.....	No development.		
H 2	p.m. Oct. 25.....	No development.		
I 1	p.m. Dec. 16.....	No development.		
I 2	p.m. Dec. 18.....	No development.		
J 1	p.m. Jan. 9.....	9 a.m. Jan. 27.....	17 das. 16 hrs. nearly	Helped out of shell.
J 2	p.m. Jan. 11.....	No development.		
K 1	6 ^b 15 ^m p.m. Feb. 10.....	No development.		
K 2	2 ^b 55 ^m p.m. Feb. 12.....	3 ^b 30 ^m to 4 a.m. Feb. 28....	15 das. 12½ to 13 hrs.	(A 15)

TABLE 185.—Concomitant incubation: Two crosses and two normals, with eggs interchanged.

Birds.	Eggs.	Laid.	Hatched.	Incubation.
σ^a Archangel (Ar 1)	B 1	4 to 6 p.m. Feb. 19	Pricked shell.....	Not certain.
φ Ring-dove (D 2)	B 2	7 to 9 a.m. Feb. 21	No development.	
σ^a Ring-dove (G)	Z 1	4 to 6 p.m. Feb. 19	12 to 2 Mar. 6....	14 das. 19 to 21 hrs.
φ Ring-dove (G)	Z 2	7 to 9 a.m. Feb. 21	5 to 6 a.m. Mar. 7....	13 das. 21 to 22 hrs.
σ^a Black Jap. tumbler (T 3)	H 1	5 p.m. Feb. 19....	12 to 1 Mar. 7....	15 das. 19 to 20 hrs.
φ Ring-dove (L 1)	H 2	7 to 9 a.m. Feb. 21	Failed.	
σ^a Ring-dove (C)	Z 1	4 to 6 p.m. Feb. 19	5 to 6 a.m. Mar. 7....	15 das. 12 hrs., nearly.
φ Ring-dove (C)	Z 2	7 to 9 a.m. Feb. 21	p.m. Mar. 7.....	14 das. (A 15)

TABLE 186.—Contemporaneous incubation period in 4 cases.

Pairs.	Parents.	Eggs.	Laid.	Hatched.	Incubation.
I	Com 4 (chequered).....	{ B 1	p.m. July 8, 1898.....	Before 6 a.m. July 27.....	18 das. 12 hrs., ca.
	Com 5 (slate—2 bars).....	{ B 2	p.m. July 10.....	At 6 a.m. July 27.....	16 das. 12 hrs., ca.
II	Com 1 (3 brown bars).....	{ H 1	p.m. July 9.....	1 to 2 p.m. July 27.....	17 das. 19 to 20 hrs., ca
	Com 1-A 1 (slate—3 bars).....	{ H 2	p.m. July 11.....	Before 6 a.m. July 28.....	16 das. 12 to 20 hrs.
III	Hom 2 (slate—2 bars).....	{ F 1	p.m. July 9.....	11 ^h 40 ^m a.m. July 27.....	17 das. 18 to 20 hrs.
	Com 1-D 2 (slate—3 bars).....	{ F 2	Before 2 p.m. July 11.....	By 6 a.m. July 28.....	16 das. 12 to 20 hrs.
IV	Ring hybr. (alba-ris).....	{ P 1	7 ^h 05 ^m p.m. ¹ July 9.....	6 a.m. July 27.....	17 das. 10 to 11 hrs.
	Homer.....	{ P 2	p.m. July 11.....	No development.	

Summary: I to III are 3 pairs of common pigeons; IV is a cross of a male ring (*alba* × *risoria*) × female homer. Time of IV nearly agrees with II and III; is a little less for their first eggs; it is considerably less than first of I, II, and III agree on second eggs; the first egg has longer time, probably due to lighter sitting for first two days. (A 15)

¹ The figure given here, 7^h 05^m, is almost certainly wrong; the correct time was almost certainly 2^h 05^m. If this is true the incubation time for this egg is 5 hours longer than indicated by the calculation given above; i.e., it was 17 days plus 15 to 16 hours.—EDITOR.

TABLE 187.—Normal incubation time of *Ectopistes migratorius* (4 pairs).

Pairs.	Laid. ¹	Hatched.	Incubation.
I F	5 ^h 25 ^m p.m. Apr. 28, 1897.....	2 to 3 p.m. May 11.....	13 das., less a few hours.
II C	p.m. Aug. 22, 1897.....	Before 2 ^h 30 ^m p.m. Aug. 4.....	12 das. 12 to 18 hrs.
III D	6 p.m. Aug. 15.....	Aug. 28.....	12 das. 12 to 18 hrs.
I H	5 to 6 p.m. May 30.....	a.m. June 12.....	12 das. 12 to 13 hrs.
IIb A	7 ^h 05 ^m p.m. May 9.....	7 ^h 20 ^m a.m. May 22.....	12 das. 12 hrs. 15 m.
III B	p.m. Apr. 30.....	Before 4 p.m. May 13.....	13 das. less a few hours. (A 15)

¹ Clutches of only 1 egg each are laid by this species.—EDITOR.

TABLE 188.—Incubation period of ♂ passenger × ♀ ring hybrid (*alba-risoria* × *risoria-alba*, C 1).

Eggs.	Laid.	Hatched.	Incubation.
A 1	3 ^h 20 ^m p.m. Apr. 4, 1898.....	No development.	
A 2	7 ^h 40 ^m a.m. Apr. 6, 1898.....	4 to 5 a.m. Apr. 20.....	13 das. 20½ to 21½ hrs.
C 1	4 ^h 30 ^m to 5 ^h 30 ^m p.m. Apr. 15.....	5 a.m. May 1.....	15 das. 12 hrs., nearly.
C 2	a.m. Apr. 17.....	No development.	(A 15)

TABLE 189.—Incubation period for ♂ *Ectopistes* (I.A) × ♀ ring-dove (L 2).

Eggs.	Laid.	Hatched.	Incubation.
A	3 to 5 ^h 30 ^m p.m. Jan. 26.....	Failed.	
B 1	4 to 6 p.m. Mar. 1.....	8 a.m. Mar. 16.....	14 das. 15 hrs., ca.
B 2	9 ^h 48 ^m a.m. Mar. 3.....	No development.	
C 1	5 ^h 10 ^m p.m. Mar. 13.....	No development.	
C 2	9 ^h 02 ^m a.m. Mar. 15.....	No development.	
D 1	4 ^h 50 ^m p.m. Mar. 27.....	Failed to hatch.	
D 2	9 ^h 07 ^m a.m. Mar. 29.....	6 ^h 10 ^m a.m. Apr. 12.....	14 das. 21 to 22 hrs.
E 1	5 ^h 02 ^m p.m. Apr. 9.....	6 ^h 50 ^m a.m. Apr. 24.....	14 das. 14 hrs.
E 2	8 to 9 a.m. Apr. 11.....	No development.	
F 1	4 ^h 42 ^m p.m. Apr. 18.....	Failed.	
F 2	8 ^h 25 ^m a.m. Apr. 20.....	4 to 5 a.m. May 4.....	14 das. less 4 to 5 hours.
G 1	5 ^h 10 ^m p.m. Apr. 30.....	1 ^h 50 ^m p.m. May 14.....	14 das. less 3 hours.
G 2	9 ^h 14 ^m a.m. May 2.....	3 ^h 41 ^m p.m. May 15.....	13 das. 6 hrs. 27 m.

TABLE 189—(continued).

Eggs.	Laid.	Hatched.	In incubation.
H 1	5 ^b 37 ^m p.m. May 10.....	No development.	
H 2	9 ^b 36 ^m a.m. May 12.....	4 to 5 a.m. May 26.....	14 das. less 5 to 6 hrs.
I 1	4 ^b 05 ^m p.m. June 5.....	Developed but failed to hatch.	
I 2	6 ^b 21 ^m a.m. June 7.....		
J 1	p.m. June 28.....	Developed but failed to hatch.	
J 2	a.m. June 30.....		
K	3 ^b 42 ^m p.m. July 10.....	No development.	
L	p.m. Aug. 4.....	6 a.m. Aug. 19	14 das. 12 hrs., nearly.
M 1	5 ^b 48 ^m p.m. Aug. 13.....	Partly hatched but died in shell.	Not quite 15 days.
M 2	8 ^b 37 ^m a.m. Aug. 15.....	2 ^b 30 ^m p.m. Aug. 28; opened.	
N	p.m. Sept. 8	No development.	
O 1	p.m. Oct. 6.....	No development.	
O 2	a.m. Oct. 8.....		
P 1	5 to 6 p.m. Mar. 24, 1898.....	1 to 2 p.m. Apr. 9.....	15 das. 19 to 21 hrs.
P 2	9 ^b 30 ^m to 10 a.m. Mar. 26, 1898.....	6 a.m. Apr. 11.....	15 das. 20 to 20½ hrs. (A 15)

TABLE 190.—Summary on period of incubation.

♂ Common dove \times ♀ common dove, period for first egg, 18 days, nearly.
second egg, 17 days, nearly.

♂ *Ectopistes* × ♀ *Ectopistes* (single egg in clutch), 12½ days, nearly.

♂ Ring-dove \times ♀ ring-dove, period for..... {first egg, 15 days + or -. second egg, 14 days - or +.

Crosses of common doves and *Ectopistes* with ring-doves:

15

TABLE 191.—Crosses of *St. humilis* with *St. risoria*; eggs incubated simultaneously.

Pairs.	Eggs.	Laid.	Hatched.	Incubation.
I ♂ St. humilis ♀ St. humilis	F 1	p.m. Aug. 31, 1900	5 to 6 a.m. Sept. 14	13 das. 12 to 14 hrs.
	F 2	5 to 6 a.m. Sept. 2	5 to 6 a.m. Sept. 15	12 das. 20½ hrs.
II ♂ humilis ♀ risoria	F 1	p.m. Aug. 30	(hr.?) Sept. 13	13 das. 12 to 23 hrs.
	F 2	a.m. Sept. 1	3 ^½ 30 ^m p.m. Sept. 14	13 das. 6 to 8 hrs.
III ♂ alba-ris × ris-alba ♀ risoria	L 1	p.m. Aug. 29	(hr.?) Sept. 13	14 days +. ¹
	L 2	a.m. Aug. 31	a.m. Sept. 15	14 days +. (R 18)

¹ "I don't think this is quite a typical instance." (The period is usually a little longer for the first egg.—EDITOR.)

"Comparing the second eggs of pairs I and II, the cross (II) gave a period of 13 days plus 6 to 8 hours; the uncrossed pair (I) showed a period of 13 days less $2\frac{1}{2}$ to $3\frac{1}{2}$ hours. This is a difference of a little less than 12 hours."

CHAPTER XVII.

ON THE DIVISIBILITY OF CHARACTERS.

Specific characters, by hybridizing, can be divided, subdivided, etc., until it is seen that two different characters are brought to an equality. Where two species have different characters, one can get every degree of splitting or division.

If the characters of the crossed birds are the same, then the resulting hybrid has the full unreduced character.

AN EXHIBITION OF HYBRIDS¹ SHOWING THE DIVISIBILITY OF CHARACTERS.

Professor Brooks has defined heredity as "the resemblance of child to parent, of offspring to ancestor; while the difference between child and parent is called variation."²

Most of us feel that this definition covers the ground. In the investigation of heredity, or in a discussion of it, it is, however, extremely difficult to limit ourselves to single things; and the only way to do it—if there is any way to do it—is to get some particular objects before our eyes and make the effort to see for ourselves what is to be seen. At this time I shall content myself with exhibiting a few pictures and a few living birds to illustrate what happens in the crossing of different species of pigeons.

In this field, as in most other fields, a single fact, or what we can learn from a single fact, is simply illustrative of what can be found in the rest of the field. The first hybrids that I shall discuss are those derived from the common ring-dove and the nearly extinct passenger-pigeon. Both sexes of the passenger-pigeon have been carefully represented in color drawings (the male in pl. 28 and the female in pl. 29). The main distinction between the sexes is that the female has a duller color, has more brown, is rather larger, and has more numerous spots on the wing. The male has apparently lost a certain number of these spots and has reduced the size of the rest, some of them being so minute that they can scarcely be seen. Some of them are concealed under the wing-coverts, where, of course, they can have very little ornamental importance.³ The blond ring-dove may also be seen in color (pl. 8); the neck-mark or ring of an adult female is better shown in pl. 31; the ring of a juvenal ring-dove is also shown in pl. 31.

The hybrids from the passenger \times ring-dove cross, of which some 8 or 10 have been obtained, were all males. The father of all these hybrids was a passenger-pigeon and the mother a ring-dove. The hybrids (one shown in pl. 30) will perhaps best be compared with the male of the paternal species. An examination of the neck-mark attests that in this respect the hybrid stands as nearly intermediate between its two parents as is possible. The color of this region is lighter in the hybrid than in the passenger-pigeon, and that is of course in the direction of the ring-dove. The passenger-pigeon shows a plain iridescence on the side of the neck. In the hybrid there is a slight iridescence; and it has in addition the differentiation of the feathers of the ring that carries it beyond the passenger-

¹ The manuscript (SS 11) used in this chapter is a stenographic report, partly corrected by the author, of a lecture at Woods Hole, July 19, 1906. The editor has adjusted the manuscript to a place in this volume.

² W. K. Brooks, Proc. Amer. Phil. Soc., No. 182, April 1906, p. 70.

³ See text-figs. 5 to 7, Vol. I.

pigeon in the direction of the ring-dove. The differentiation does not meet on the back of the neck as it does in the case of the ring-dove, but it extends farther towards the middle of the back of the neck than does the iridescent area of the passenger-pigeon.

The tail of the hybrid is considerably longer than it is in the ring-dove, but falls plainly short of the length attained in the passenger-pigeon. The general appearance of the bird in size, color, and marking is intermediate. There are none of the black spots of the passenger-pigeon shown distinctly in the hybrid, except in the feathers on the posterior border of the wing. In the case of living birds⁴ one could probably identify the hybrid whose picture has just been shown, although the two birds together there are nearly of the same size. One can see the marking on the neck of the one bird, and note that although it is slightly separated posteriorly it comes near to a union on the back of the neck. A close examination of the hybrid shows that there are some obscure marks on the scapulars, directly in the middle of the back, and that there are also the faintest traces of some marks in the tertials. Perhaps I have sufficiently described this hybrid; I think the bird exhibited here is a fair intermediate between the two parent species.

When I first began my experiments in hybridization I had much curiosity, hardly knowing what to think would be the result of crossing two birds so different as those just described. So far as the wild pigeons are concerned it was a wholly unknown field at the time. I continued my effort, however, and got all the hybrids I could—in the case of these two particular species I obtained 8 or 10 offspring. These were all males and all of the same color. It was difficult to find any difference between them. There was a slightly stronger trace of the spots in some cases than in others, and a slight difference in the length of the tail. They never, however, went much beyond the length seen in the individual exhibited here.

⁴ Some live birds were demonstrated in this lecture.—EDITOR.

EXPLANATION OF PLATE 32.

Fig. 1. Neck-mark of common pigeon \times ring-dove hybrid. Toda del., Feb. 1903. $\times 1$

Fig. 1. Rows drawn so as to show the extent of black and gray; sharply cut feathers, and feathers less cut, passing gradually into regular neck-feathers at each end of the rows and also above and below the rows.

Figs. 2–6. Natural size. Show five feathers (left side) taken (Feb. 27, 1903) as follows:

Fig. 2. Eighth feather of second row (counting from above downward). In this row we see 6 feathers shaded. These feathers are not black, but gray with pale-gray tips.

Fig. 3. Ninth feather of third row. This from just below the feather shown in fig. 2. Here also 6 feathers shaded, the 2 or 3 central ones becoming darker gray; darker on posterior web.

Fig. 4. Eighth feather of fourth row (fourth of 7 shaded feathers). From directly under that of fig. 3. Black or blackish gray; darkest on dorsal web.

Fig. 5. Eighth feather of fifth row. Not quite so dark as that of fig. 4.

Fig. 6. Seventh feather of sixth row. Slightly darker than fig. 2, but lighter than figs. 3, 4, or 5.

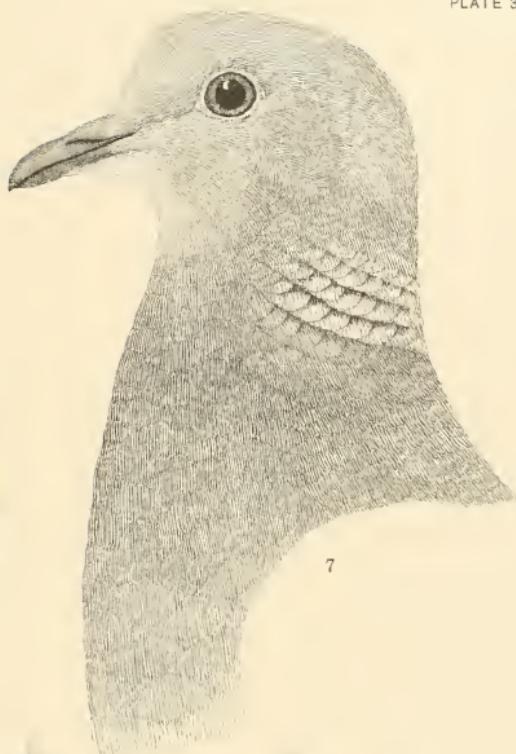
Fig. 7. Hybrid between a male black Japanese pigeon (T 3 = common pigeon, with a touch of fantail) and a female ring-dove (*St. risoria* \times *St. alba*, X W 2 D 1). $\times 0.6$. Toda del., Feb. 1903.

This hybrid (T 1) was hatched Aug. 5, 1902. Head and neck to show the neck-mark (neck held at normal length). Three rows show blackish bases and metallic-gray tips. Above these three is one row in which blackish bases (dark gray) show only on lifting the feathers; the tips are gray becoming vinous iridescent at extreme tip. Then another row with little differentiation.

Below the three rows comes one which, in a little greater extension, shows black bases on 5 to 6 feathers, tips gray, passing into vinous iridescence at extreme tips; then another row showing no black, but tips lustrous vinous; only about 4 or 5 being cut shorter at tips. Thus there are about 7 rows.

All around the black and gray region, which corresponds to the ring-neck in the ring-dove, there is vinous iridescence. No plain iridescence on front of neck, and but little on back of neck.

The same neck-mark flat, and isolated feathers, shown in figs. 1–6.



1
2
3
4
5
6
7

Neck-mark of common pigeon \times ring-dove hybrid; separate feathers from mark shown in figures 2 and 6. Toda del., Feb. 1903.



This bird was the only one of the fraternity having a white rump; it has 13 tail-feathers. The general color is gray; the wings are washed with brown, increasing on long coverts and tertials. The lower web of the feather has the most brown, and this is the only suggestion of dark chequers, but there is nothing like a distinct chequer. Occiput freckled with white. Iris bright red, with orange next to pupil. The neck-spot is a little stronger than the one shown in plate 32, fig. 7, but only 3 to 4 rows show black without lifting feathers. Feathers about the same as those in plate 32. During 1907-8 this hybrid acquired white tail-feathers.

TEXT-FIGURE 2.—Head and neck-mark of an adult male hybrid (K 1) between a white male fantail (*Columba laticauda*, F) and a female blond ring-dove (*Streptopelia risoria*, B). Hatched Dec. 1, 1897; age 6 years. $\times 1.2$. Toda del., Jan. 1903.



TEXT-FIGURE 3.—Neck-mark of African owl pigeon, *C. turbata*; about 3 months old. Natural size. Hayashi del., 1900.

Shows neck-feathers of first or juvenal plumage; first molt was, however, already in progress. The rows of feathers are quite distinct and the distinctness is not overdrawn in the figure; a little less distinct than in the stock-dove (see text-figure 4).

It will be seen, then, in this case, that we get nothing out of the pair of birds which is not in them to start with; when we have once learned that simple lesson we can begin to calculate what will happen in the case of any new cross. It is not now a matter of so great curiosity to me when I cross a pair of birds of different species; I can usually forecast in a general way what the result will be.

The next hybrid to be considered had an altogether different parentage, in so far as the male parent is concerned. The mother was the same species of ring-dove and the father a common pigeon—the homer. The homer differs from other common pigeons mainly in the size of the beak, which has a basal portion large as compared with the ordinary pigeon. The hybrids⁵ (pl. 32 and text-fig. 2) have also

⁵ The hybrids shown in the plates have other common pigeons, not homers, as sires.—EDITOR.

EXPLANATION OF PLATE 33.

Figs. 1–6. The Nicobar pigeon, *Calanias nicobarica*. Habitat: From the Nicobars and Mergui Archipelago through Malay Archipelago as far as Solomon Islands (Salv., p. 617). Natural size. Hayashi del., Feb. 1903.

The feathers of the side of the neck (the region of the neck-mark in other pigeons) are much elongated. A similar elongation is seen in the hacked partridge (see Latham, Hist. of Birds, Vol. VIII, pl. ccix, p. 307). These long feathers are 37 mm. long (some are longer in Nicobar). When erected they appear like those on the neck of the ruffed heath cock.

Neck-feathers (left side).

Fig. 1, from just under ear-coverts. Fig. 2, from middle of upper breast. Fig. 3, from just above middle of side. Fig. 4, from same height on mid-back of neck. Fig. 5, from middle of side of neck. Fig. 6, entire head and neck. $\frac{1}{2}$ natural size.

Figs. 7, 8, 9, 10, four feathers from neck of an adult male *Columba guinea*, and four feathers, figs. 11, 12, 13, and 14, from neck of a hybrid between a male *C. guinea* and a female *C. livia*. $\times 2$. Hayashi del., April 1903.

The split or bifurcation is stronger in the male parent, while the iridescence is stronger in the hybrid, as we should expect, since *C. livia* is much more iridescent than *C. guinea*.

7 and 11. Taken (in each case) just below ear coverts on the left side; these are red and bifurcated in the parent, but gray and entire in the hybrid.

8 and 12. From near mid-height, side of neck. Longer and slenderer, and red in the male; wider and shorter, and gray in the hybrid. The split is longer in male, about equal in width.

9 and 13. From near lower boundary of bifurcated feathers on side of neck (in line with 1 and 2); split wider in the male.

10 and 14. From still lower. Little bifurcation in the male; none at all in the hybrid.

EXPLANATION OF PLATE 34.

Figs. 1, 2, 3. Adult male *St. risoria* ($\frac{1}{2}$)—*Spil. suratensis* ($\frac{1}{2}$) \times *St. alba* ($\frac{1}{2}$) hybrid (T 1). From egg of May 1, 1903. $\times 2$ Toda del., April 1904.

Fig. 1. The neck-mark, here shown flat, is smaller than in the male parent figured on this plate, figs. 4–6. The divided tip of the feathers is also here less marked than there. The neck-mark and divided tip of the *suratensis* grand-parent have thus been twice divided. The extent of the white tip on the feathers of the mark has also suffered two reductions from *suratensis* toward the ring-dove.

Fig. 2. Fifth feather, third row (right side).

Fig. 3. Second feather, fifth row (right side).

Figs. 4, 5, 6. Neck-mark of adult male hybrid between a male ring-dove hybrid and a female Surate turtle-dove. $\times 2$. Hayashi del., Nov. 1902.

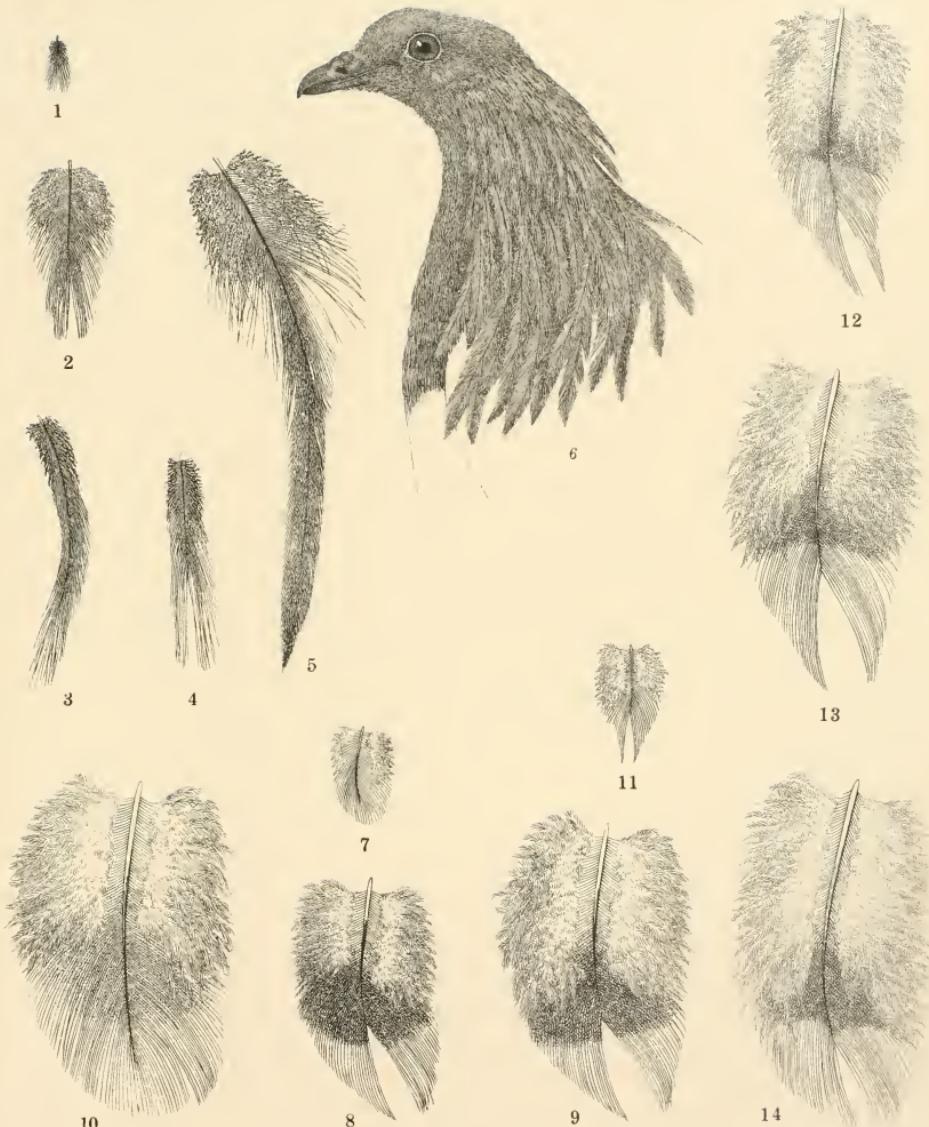
Sire: *Streptopelia alba-risoria* \times *St. risoria-alba* (D 2). Dam: *Spilopelia suratensis* (Tt). Hybrid (F) hatched Sept. 25, 1899.

Fig. 4. This hybrid may be compared with *St. risoria*, *Spil. tigrina*, and *Spil. chinensis*, the latter being practically the same as *Spil. suratensis* in its neck-mark.

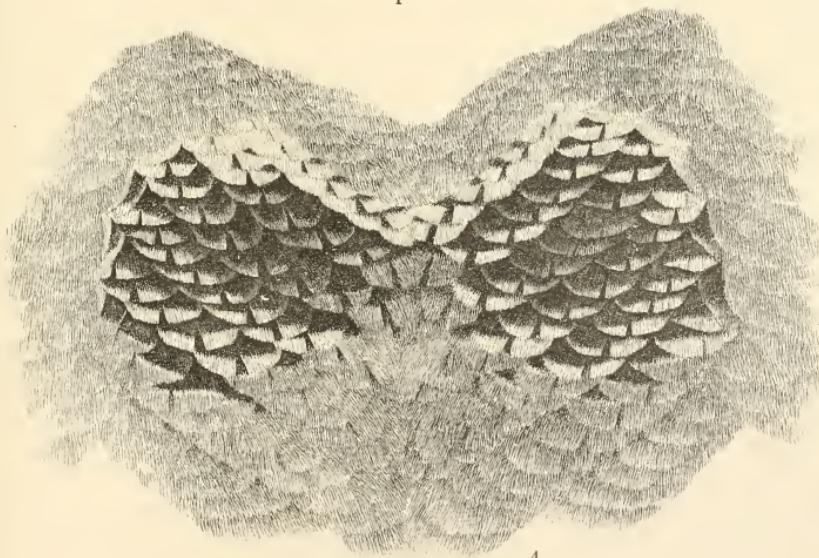
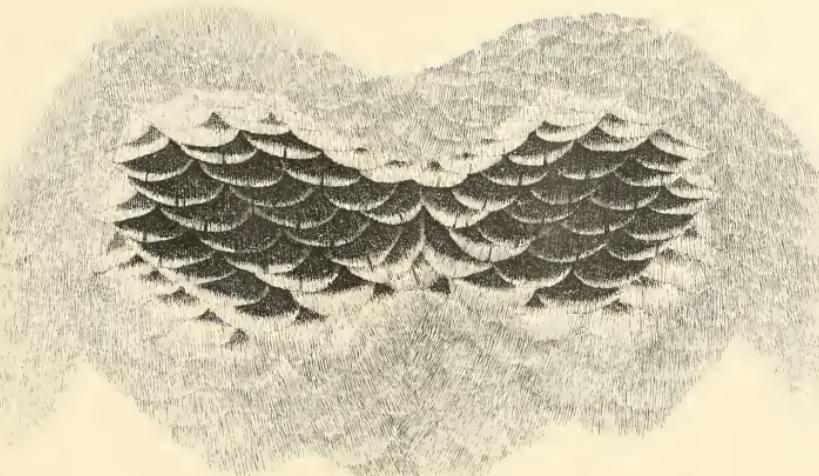
The rows are reduced in number and extent and the bifurcation is intermediate between the parents. It is in the middle region that the black ring takes most effect, some of the feathers tending here to lose the white tips. The coalescence includes about 2 rows plainly; i.e., about half as much as *chinensis*. This hybrid shown in color plate 25, fig. B; his dam in pl. 24.

Fig. 5. First of fifth row, right side. The right (front) half is gray with long vinous tip; the left web is differentiated and shortened, but only gradually.

Fig. 6. Eighth feather, fourth row (corresponds with fifth row in *T. chinensis*) left side. This shows full differentiation, and narrow white tips.



The Nicobar pigeon, *Caloenas nicobarica* (figs. 1-6). From the Nicobars and Mergui Archipelago through Malay Archipelago as far as Solomon Islands (Salv., page 617). Selected feathers from *Columba guinea* (figs. 7-10) and from a *C. guinea* \times *C. livia* hybrid (figs. 11-14). Figures 1-6, $\times 0.6$, other figures natural size. Hayashi del., Feb. 1903.



Figs. 1-3. Adult male, *St. risoria* ($\frac{1}{8}$)-*Spil. suratensis* ($\frac{1}{4}$) \times *St. alba* ($\frac{5}{8}$) hybrid (T1). From egg of May, 1903. $\times 2$. Toda del., Apr. 1904.

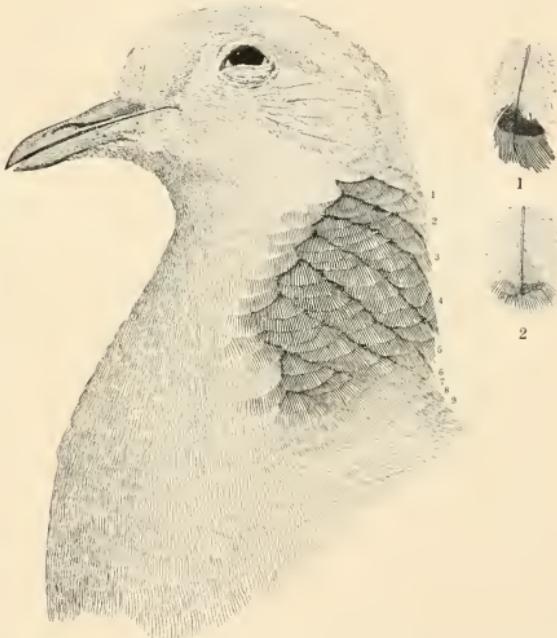
Figs. 4-6. Adult male, *St. risoria* ($\frac{1}{4}$)-*St. alba* ($\frac{1}{4}$) \times *Spil. suratensis* ($\frac{1}{2}$) hybrid (F). Sire of T1 shown above. $\times 2$. Hayashi del., Nov. 1902.

a rather strong beak for their size. The differentiation on the side of the neck should be especially noted. It is a little like what we see in the passenger-ring-dove hybrid. A decided glistening is easily seen, and there is a well-marked differentiation of the feathers. A dissected or flat view of this mark is shown in pl. 32. Some five or six rows of the feathers are apparently stiffer and more scale-like than the rest of the neck-feathers. The two spots come near to meeting on the back, but they do not quite do so. The homing pigeon, like all the common pigeons, has a large amount of iridescence on the neck, and the ring-dove has the black collar as already noted. Now, between the black collar and the iridescence one gets the markings of this

This female was photographed after death by Mr. Hubbard (photo., Vol. I, pl. 9). The tips of the feathers are too evenly rounded (see drawing of feather from middle of sixth row). Nine rows show differentiation, metallic green. The iridescence covers 9 rows, diminishing rapidly on lower 3 rows, until, in the lowest or ninth row, only one or two feathers are weakly differentiated. The first feathers of the rows of the front-neck show a touch of iridescence. The limitation of the iridescence of these rows, the front-neck showing no iridescence except in feathers next to the posterior rows, brings this dove clearly between *Columba livia* and *C. fasciata*. *C. palumbus* stands lowest of the three, and next to the turtle-dove (*Turtur*). The same order applies to the reduced wing-bars.

FIG. 1. A feather from middle of sixth row (counting down). Middle part blackish gray, corresponding to black of ring-dove and turtle-dove. The wide tip shows blunt ends rather than tapered ends. $\times 2$.

FIG. 2. From front end of ninth row; the front web is vinous and is like others of the fore-neck, but the hind web shows weak iridescence and stronger barbs, though not so strong as in fig. 1. $\times 2$.



TEXT-FIGURE 4.—Neck-mark of adult female stock-dove, *Columba aenae*. Habitat, Western Palaeartic region to Eastern Turkestan. Natural size. Hayashi del., Aug. 1902.

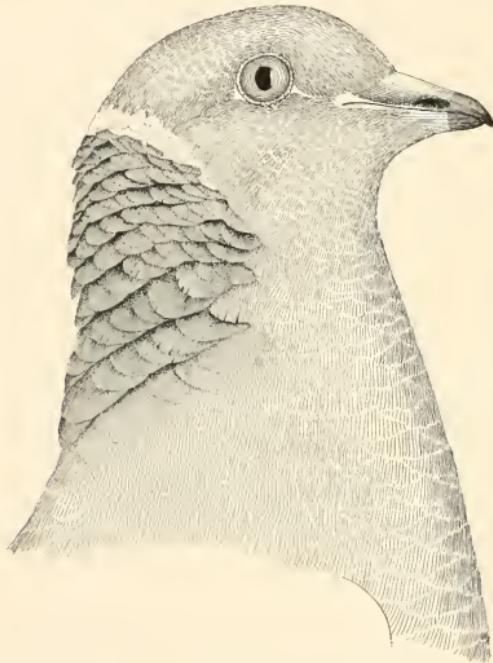
hybrid, which, one might at first say, does not really resemble either parent. Examination will show, however, that the mark of the hybrid has all the fundamentals of the marks of both parents.

The nature and several modifications of this mark in the common pigeon and its allies (mostly *Columba*) are shown as follows: The African owl-pigeon (*C. turbata*) in text-fig. 3; the stock-dove (*C. aenae*) in text-fig. 4; the band-tail pigeon (*C. fasciata*) in text-fig. 5; the wood-pigeon (*C. palumbus*) in text-fig. 6; *C. leucocephala* in pl. 35; *Cal. nicobarica* in pl. 33. That the neck-mark of hybrids from two crossed members of the genus *Columba* is also⁶ an intermediate one may see in the

⁶ The hybrids previously described were of species belonging to different families.—EDITOR.

case of the *C. guinea* \times *C. livia* cross. The very peculiar mark of *C. guinea* (see text-fig. 7) is easily recognized in that of the hybrid which is shown in text-fig. 8; but in the latter the divided and bristling characteristics of the feathers concerned are less striking, and in some feathers there is no such division at all. This difference is recorded in pl. 33.

I may remark incidentally that the ring-dove gets its ring from the turtle-dove, and the turtle-dove has a "pair of spots" such as you see in the Japanese turtle-dove—six or seven rows of feathers with whitish or grayish edges and darker basal portions. In the homer \times ring hybrid referred to above the dark color of the male

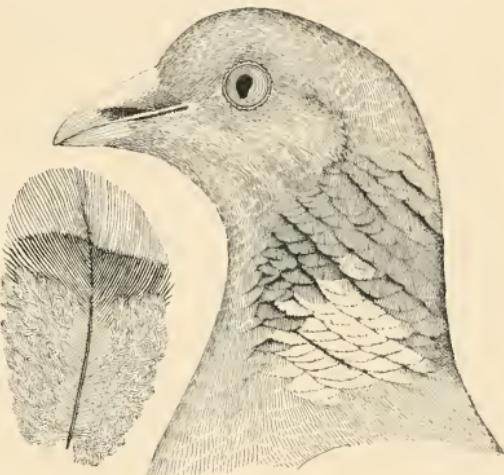


TEXT-FIGURE 5.—Neck-mark of adult male band-tail pigeon, *Columba fasciata*. $\times 1.2$. G. A. Wilson del., 1900.

parent is reduced a great deal. There are here lighter edges to the feathers and dark-gray basals. The ring-dove and the turtle-dove agree in the number of rows of feathers involved in the neck-mark, and in every hybrid that we make between either of them and other doves that have iridescence we get the sort of blend of neck-mark seen in this homer \times ring hybrid. Adding another word to this digression, I may remark that the common pigeon and the passenger-pigeon, and all the rest of the group of pigeons, have probably been derived from an ancestor differing not very greatly from the Japanese turtle-dove. The simple condition of neck-ring and body-color, etc., found still in *T. orientalis*, represents a very natural starting-point for all the species of pigeons, although there are more than 500 species recognized to-day in this group of birds.

Eleven rows are involved in the neck-mark; the upper and lower rows are least differentiated. Some front feathers adjoining these rows are sharp-cut, stiff, and scale-like. The white is carried to the upper limit; in ring-doves it is carried to both upper and lower limits or edges of the mark, while in the wood-pigeon (*C. palumbus*, text-figure 6) it remains in the more narrowly differentiated area corresponding nearly with the turtle-dove spot.

To show how this divisibility of specific characters works out when we carry it a little further, we will consider another pair of birds that I have worked with a little longer. The Surate turtle-dove (*Spilopelia suratensis*) is illustrated in colors in pl. 24. Attention may be especially called to the well-defined and peculiar character of the spots on the neck and to the central dark median streak of the wing-feathers. The feathers of the neck have a dark base and a white tip, which give the neck a sort of speckled appearance, white and black both showing, owing to the fact that each feather is split at the tip. The feathers are arranged in rows, and there is a larger number of rows than in the Japanese turtle-dove. The species *suratensis* has advanced considerably beyond the ancestral turtle-dove, both in the neck-mark and in the wing-feathers. In the Japanese bird is seen a simple



There are 11 rows of feathers in the neck-mark, as in the band-tail (*C. fasciata* text-figure 5), and some additional front feathers are affected. The light tips are seen on the lower 6 rows, which correspond to the spot on the turtle-dove. The tips are whitish or light buff, as the sample feather shows. A dark or blackish area follows the light tip; this corresponds to the dark area in feathers of turtle-doves.

TEXT-FIGURE 6.—Neck-mark of adult wood-pigeon, *Columba palumbus*. Natural size. G. A. Wilson del., 1900.
Hayashi del. separate feather.

dark center with a light reddish edge. In *suratensis* the dark center has been reduced to a narrow median streak which is somewhat enlarged towards the end.⁷

The female Surate turtle of the illustration is the mother and a ring-dove⁸ the father of the hybrid shown in pl. 25. The first thing to notice concerning it is that its size is about that of the two parent species, which are nearly equal in size; the hybrid therefore agrees in this respect with both parents. The bird as a whole is considerably lighter than the mother, considerably darker than the father. But in order to see how neatly an intermediate character comes out, one may best examine the feathers on the neck. Here it will be found that the size of the spots is somewhat "reduced" as compared with the mother, but considerably "enlarged"

⁷ The form nearest related to *Spil. suratensis* is the Chinese turtle-dove (*Spil. chinensis*), which has completely obliterated this median streak; its neck-mark, like that of *suratensis*, covers many rows, meets with its opposite on the back of the neck, and is composed throughout of white-tipped, bifurcated feathers. (In text-fig. 10 these points are made clear, and also a comparison of this with other forms is made possible.—EDITOR.)

⁸ This bird was of "blond" color but an *alba-risoria* × *risoria-alba* hybrid.—EDITOR.

as compared with the father. Reference to pl. 34 will make this clear. The father's black ring is not more than half the width of that of the hybrid. Again, the arrangement of the feathers in rows can be seen more distinctly in the hybrid than in the mother, owing to the fact that the split at the tip of the feather is reduced to not more than one-half of what is seen in the mother. The interesting point is that the split does appear in the hybrid, and is of a size that would come fairly under the term intermediate. It remains to be noted that the size of the dark median streaks of the wing-feathers, in comparison with the maternal ancestor's spots, are very much reduced; but they are clearly visible in the hybrid.

TEXT-FIGURE 7.

Neck-mark of adult male guinea-pigeon, *C. guineae*. Natural size, Hayashi del., March 1903.

The neck-feathers, all around and up to the ear-coverts, are bifid (bifurcated at the tip.) See feathers and drawings on pl. 33, figs. 7 to 14. Iridescence is here very weak. The Chinese, the Surate, and tiger turtle-doves all have bifurcated feathers on the sides of the neck. These neck-feathers are arranged in *curved rows*, as can be best seen when the bird stretches its neck. This curvature of the rows is general in *Columba* and *Turtur*.



The male *risoria* × *suratensis* hybrid just described was next crossed with a white ring-dove.⁹ The result, as may be seen in pl. 26, was a further simple modification of the male parent's pattern—everything was made lighter and the size of the neck-spot still further reduced, and even the slight division at the tips of the feathers appears in some feathers. This is better seen in the flat view of the neck-mark in pl. 34. A sharpness of the extreme center (the vane) of the wing-feathers is all that remains of the median spot.

I later crossed this $\frac{1}{2}$ *risoria*– $\frac{1}{2}$ *suratensis*– $\frac{1}{2}$ *alba* male hybrid with a dark hybrid from a cross of the blond ring and the Chinese red ring (*St. humilis*). An adult

⁹ The white ring (*St. alba*) has been figured in pl. 8, and described in Chapters VII and XV.—EDITOR.

male of this latter species is shown in pl. 21, a juvenal male also in pl. 21. This species is considerably smaller than the ring-dove. It has a quite dark reddish color. The characters of the hybrid of this last-named cross, consisting of four species, are shown in plate 26. It will be observed that the *suralensis* streaks on the wings are still preserved. Indeed, they seem to be increased, but this is only indirectly so, due to the strengthening of the pigmentation as a whole which results from the admixture of the very dark *humilis*. I have two hybrids of this class, and both have the streaks on the wing-feathers quite as shown in the illustration.¹⁰

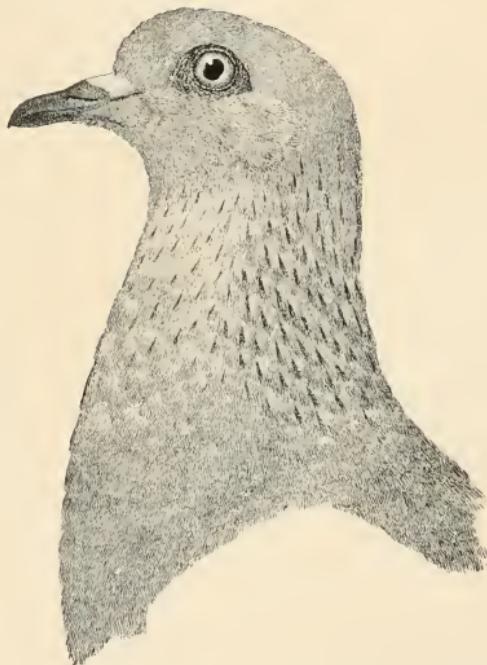
TEXT-FIGURE 8.

Neck-mark of an adult female hybrid (C) between a male *Columba guinea* and a chequered *C. livia*. Hatched May 19, 1901. Natural size. Hayashi del., Apr. 1903.

This hybrid resembles both parents in its form. The neck-feathers lie quite smoothly and the bifurcation is not apparent except on close examination. The feathers in the male parent hang loosely and present a rough, hackled appearance.

Plate 33, figs. 7 to 14, further assists in showing that the divided feathers do not cover so large an area as in the male parent; the divisions are not so deep, and are strongest on the sides and back of the neck, weakest in front.

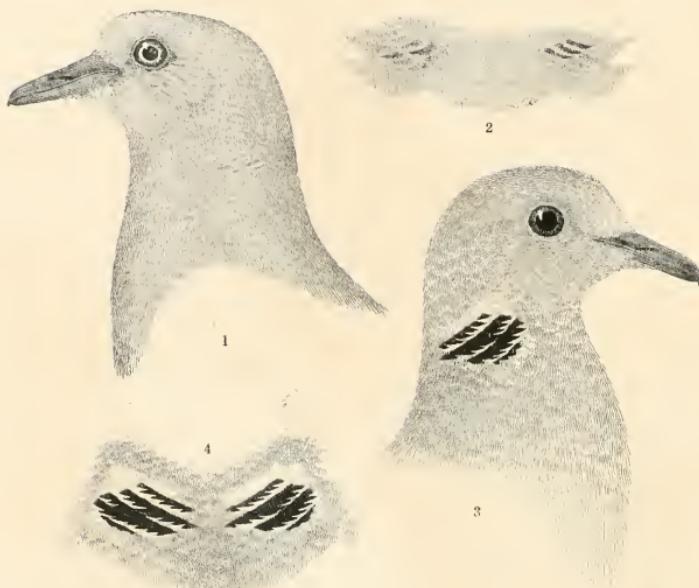
In the hybrid it is possible to see plainly the *rows* of feathers, which we could scarcely discern in the male parent. The skin around the eye is less in extent and smoother than in pure *C. guinea*. This hybrid was mated during two seasons, but produced no eggs.



I next took the offspring of this last cross (*i.e.*, the young of the male trispecific hybrid \times the *humilis* female and crossed it back with the white ring-dove. The result was the bird in this cage—the only one I have thus far obtained. It is rather light in color¹¹ and we can not yet see what the neck-mark is going to be, but one can see that the bird is of generally lighter color than its father (the mother was white; see table 154). As we go on with such studies, therefore, we find very definitely placed before us the fact that we can readily calculate what the result of crossing is going to be. We know definitely what the parents are and we can calculate mathematically—although I have never done such things myself—what the hybrid will be.

¹⁰ It should be said, however, that not all of this progeny were of this sort. The records (see table 154) show that 3 or 4 young (in a total of 12) died very early and that all of these were recorded as of "white" color.—EDITOR.

¹¹ This bird seems not to have been figured.—EDITOR.



TEXT-FIGURE 9.

1. Neck-mark of a juvenal *St. risoria* (1)-*humilis* (4) hybrid (K). Hatched July 11, 1902; age 4 weeks. Natural size. Hayashi del., Aug., 1902.

Sire, pure *St. risoria* (3); dam, *St. humilis* × *risoria* (B 2). The feathers here are more closed, or crimped together, than seen in the flat view (2).

2. Neck-mark (flat) of *St. risoria-humilis* hybrid (K); same as above. Natural size. Hayashi del., Aug. 1902.

This mark may be compared with that of the juvenal (7 weeks) *St. humilis* seen in color in pl. 21, fig. b. There may be a lagging development of color in this hybrid as compared with that in the very dark *humilis*; the rate is probably nearer that of the ring-dove, since the hybrid is three-fourths *risoria*; compare also with fig. n, pl. 31.

3. Neck-mark of an adult male *St. risoria* (1) × *T. orientalis* (13) hybrid (SO 1). Hatched May 9, 1904; alive Jan. 1915. Three-fourths natural size. Toda del., April 10, 1905.

This bird is shown in color, pl. 12. The position of the neck-mark is considerably influenced by the *T. orientalis* parent. Other details are better seen in the flat view presented in 4.

4. Neck-mark (flat) of the same hybrid as in 3 above.

The marks are somewhat smaller than in the Japanese parent; this is toward the ring-dove. The extent of the white on the feather-tips bears a similar relation to the parents.

Several accessory plumes are present within the neck-mark.

The outer portion of the second (lower) row of the left mark is divided into two rows. The division stops at about the middle of the row.

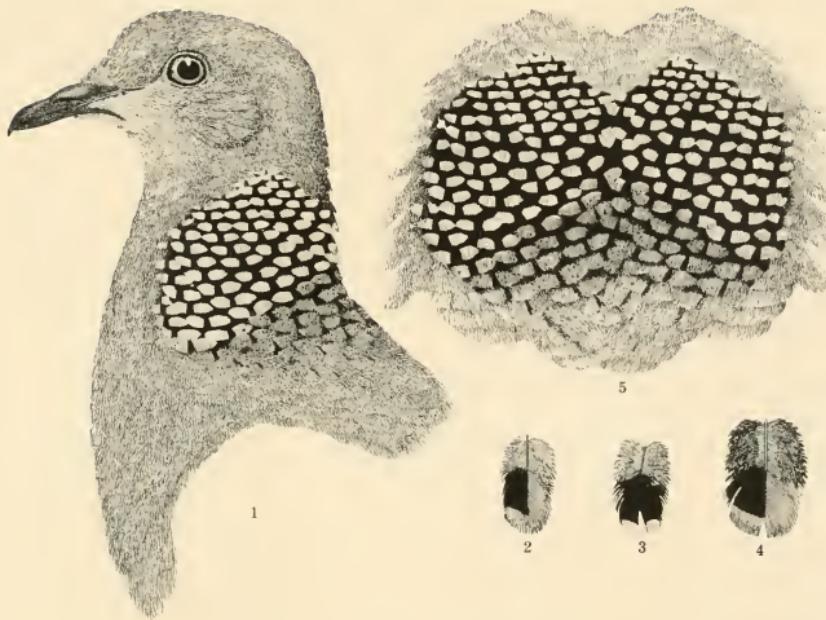


A. Adult male, *Columba leucocephala*. $\times 0.5$. Hayashi del., Mar. 20, 1903.

Habitat, Florida Keys, Bahamas, Greater Antilles; also Santa Cruz, St. Bartholomew Cozumel Islands, and coast of Honduras (Salvadori). Neck-feathers edged with velvety-black, very regularly cut and scale-like; green iridescent ("bronzy-green"). For color of male and female see plate 49, vol. I.

B. Adult *Columba domestica* \times *Turtur orientalis*. Hybrid. $\times 0.5$.

The feathers generally show light edges, though this is less marked than in *T. orientalis*. The neck-mark of hybrid shows more differentiation, stiffer feathers, and more distinct rows than in common pigeons, but less differentiation than in *T. orientalis*. Some iridescence is present, though this is difficult to reproduce.



TEXT-FIGURE 10.

Figs. 1-4. Neck-mark of an adult male Chinese turtle-dove. *Spilopelia chinensis*. Natural size. Hayashi del., Dec. 1902.

1. Side view of same bird as fig. 5, which shows both sides in one plane.

Evolution: We have to start with a form most nearly represented in *Turtur orientalis* of China and Japan. The centers of the wing-feathers there have the black rounded out full behind, leaving only the apical reddish bar, or tip.

In *T. turtur* of Europe, the dark center becomes reduced, ending in an angular point behind.

In *Spilopelia suratensis* (also bifurcated neck-feathers) the black is still further reduced to a *dark mesial stripe*.

In *Spil. chinensis* even the mesial stripe has departed, and the neck-feathers, tipped with white, are bifurcated. In these two last-named species the neck-feathers are not only bifurcated, but a *larger number of rows* are differentiated. Running back to *T. orientalis*, we find entire neck-feathers and *fewer rows*—6 down to only 3 or 4. The extension of the number of rows has also been accompanied by an extension of differentiation towards the mid-back of the neck, where the two spots plainly coalesce on the upper three or four rows.

2. First feather of fifth row (counting downward); right side. This feather comes on the boundary line and has black on the posterior web only; the front web is vinous, like the feathers of the mid-front of the neck and breast and has no bifurcation. The hind half is only touched with white close to the distal end of the black; elsewhere both webs are vinous-tipped.

3. Fifth feather of fifth row; left side. This row may be said to form the focal center of differentiation. The feather is widely bifurcated and the tips are white; the basal part up to the last one-fourth is black.

4. Seventh row; left side. Here the black becomes gray and the white vinous.

5. Neck-mark (flat) of same bird as figs. 1 to 4.

This figure shows the continuity of both spots in the mid-back region. We see here how the differentiated feathers pass gradually into vinous or brown, short tips into long tips, and bifurcated into entire. (For the color-scheme of the entire bird, in ink, see pl. 23, vol. I.—Ed.)

Now, when the blond ring (*St. risoria*) is crossed with a Chinese red ring (*St. humilis*) the hybrids obtained are intermediates of the two parent species. One of these hybrids, an adult male, is figured in pl. 22, a female in juvenal plumage also in pl. 22. Such hybrids are very measurably darker than *risoria* and lighter than *humilis*. They tend, too, to develop a little of the white edging or margin to the upper and lower limits of the neck-mark; this is towards *risoria*. In addition, these hybrids show a differentiation of color in the male and female.¹² These hybrids are fertile and give offspring like themselves. One of the offspring of a pair of such hybrids (an adult male) has been shown in pl. 23. The same bird shown in juvenal plumage (in pl. 23) will indicate the persistence of the blended body-color in the second-generation hybrids. One of the F_1 hybrids of the *risoria* \times *humilis* cross was mated back to a male *risoria*. The result, so far as the neck-mark of the juvenal plumage of this latter hybrid is concerned, is recorded in text-fig. 9. The color has there made its appearance perhaps more slowly than it does in the *humilis* parent, which now represents but one-fourth of the hybrid's parentage.

When we cross the Japanese turtle-dove (female) with the common pigeon we invariably get a bird that has more gray and less red than the Japanese parent. The general characteristics of *T. orientalis* have already been shown in pl. 1. The

¹² The females seem to be lighter, the males darker (see Chapter XIII). The stenographic report of the remarks at this point is obviously incomplete.—EDITOR.

EXPLANATION OF PLATE 36.

Neck-marks of common turtle-dove of Europe, *Turtur turtur*.

Fig. 1. Adult male (?) *T. turtur*. $\times 2$. Hayashi del., Sept. 1902.

Habitat: Western Palearctic Region in summer. In winter as far south as Shoa in Africa and as far east as Yarkand in Asia. Specimen received from Dover, England, 1902.

Very carefully drawn, giving every feather and following the natural form and arrangement. There are three main rows, of which the middle one (fourth) is the center. Two more above and one below show more or less differentiation. Eight dark feathers seen in second, fourth, and fifth rows; nine in the third, but ninth is not visible, except by spreading feathers a little. The neck has to be extended somewhat to show black in more than 3 rows.

Figs. 2-9 are of first and last feather of 4 rows (2 to 5 counting upward); right side.

- Fig. 2. First of fifth row. A short, gray spot on the hind web; tip pale ashy or grayish-white.
- Fig. 3. Eighth of fifth row. Two weak equal dark gray spots; tip of same color with neck.
- Fig. 4. First of fourth row. Black on both sides, but more behind; tip incomplete, pale gray, and sharply cut.
- Fig. 5. Eighth of fourth row. Black about equal on two sides; tip pale gray, passing to reddish; also longer barbs.
- Fig. 6. First of third row. Blackish hind-half; tip pale gray, incomplete behind, sharp cut.

Fig. 7. Ninth of third row. Black and gray in front, black behind, tip pale gray with some vinous or red, and more sharp in front than behind.

Fig. 8. First of second row. Weaker black; the front web vinous gray. No sharp tip except on hind web; tip pale vinous gray.

Fig. 9. Fifth of second row. Very weak black on hind web.

Fig. 10. Adult *T. turtur*, from Dover, 1902. $\times 2$. Hayashi del., July 1902.

Here we see only three black rows with a lower one showing a touch of dark when feathers are spread a little.

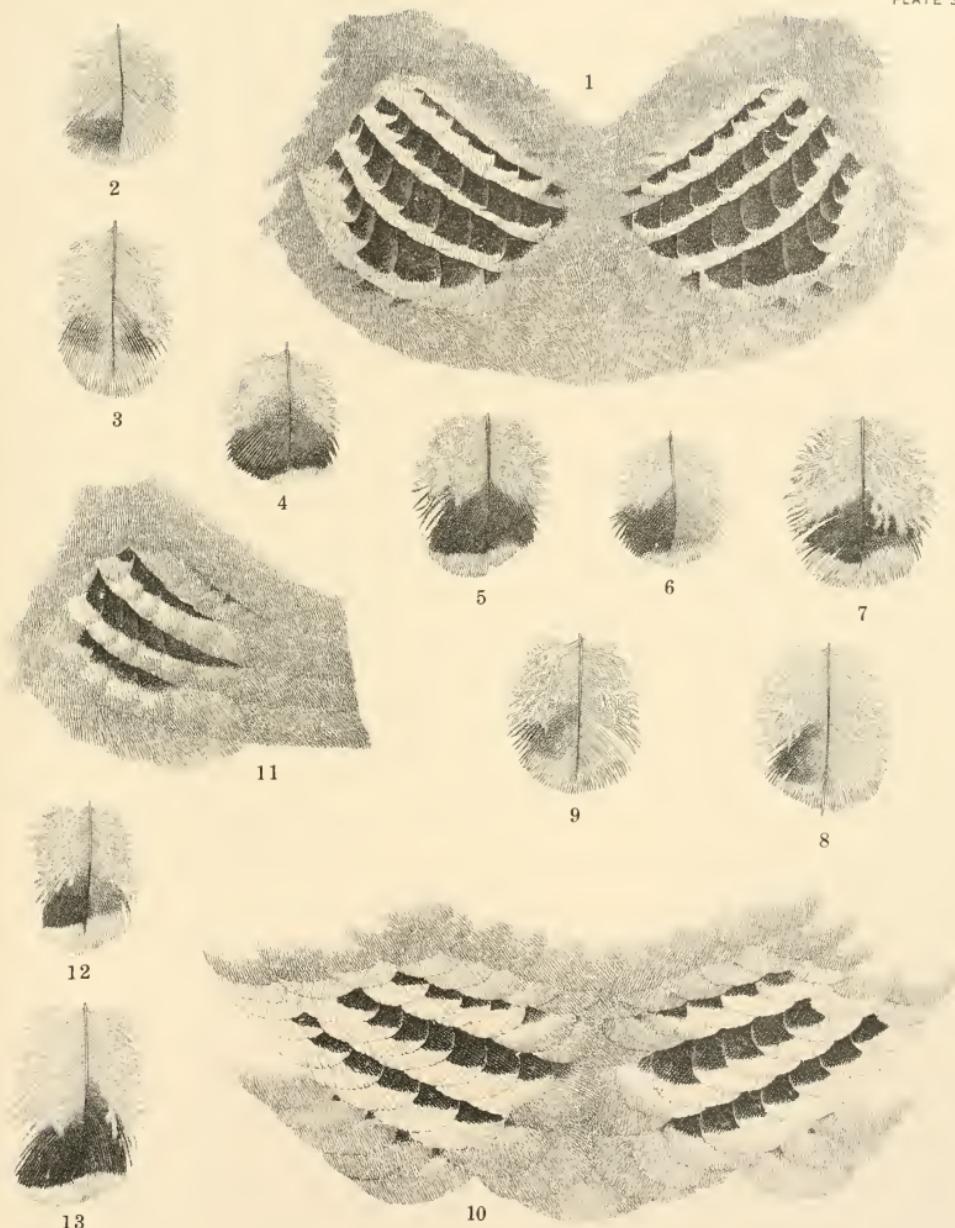
The upper (fifth) row has impure light tips, becoming more and more like neck-feathers in the mid-back region.

Fig. 11. The lowest degree of differentiation (smallest spot) found in a dozen turtle-doves from Dover, 1902. There are really only two well-marked rows; no tips normally differentiated, all showing more or less of the general color of the neck. The third row usually shows little or none of the black, and the upper row none at all except when spread out.

Fig. 12. $\times 3$. The middle black row (third) is plainly the center. The fourth feather is here shown.

Fig. 13. $\times 3$. First feather of third row (right) has black, plain behind; the tip shortened, pale grayish-white.

The seventh feather of third row (not separately figured) has less white-gray behind than in front; black on both sides.



Neck-marks of common turtle-dove of Europe, *Turtur turtur*.

neck-mark of the adult may there be noted. The common \times Japanese hybrid has the color-marks of the mother, but so washed out that one can hardly perceive that there is a distinct mark; still it is there, as may be seen by reference to pl. 35. The edges of the feathers are somewhat lighter than the basal portions; this, too, is in the direction of *orientalis*. On the neck one finds also an intermediate differentiation of the feathers toward the turtle-dove pattern in the number of the rows; and finally, the feathers of this region are found to have dark basal portions with slightly iridescent tips. These several characters, therefore, are easily divided in the first cross.

When we cross the female turtle-dove with the ring-dove (*St. risoria*) we get

TEXT-FIGURE 11.

1. Neck-mark of adult male *St. alba* ($\frac{1}{4}$)-*risoria* ($\frac{1}{4}$) \times *T. turtur* ($\frac{1}{2}$) hybrid (J 1). Same bird as shown in colored pl. 37, fig. A. Age 11 months. Natural size. Hayashi del., Apr. 1902.

Sire: *St. alba-risoria* \times *risoria-alba* (D 2).

Dam: *T. turtur* (T 1-B 1).

The figure shows the position, proportions, and intermediate nature of the neck-mark. Detailed description is given in connection with this mark drawn flat, figure 2.

2. Neck-mark of same bird as figure 1 and color pl. 37, fig. A; age 13.5 months. Natural size. Hayashi del., July 1902.

The mark comprises 5 rows of feathers:

First row (lower) shows but little of the *dark* color, which is mostly or wholly concealed when the head and neck are in the usual position.

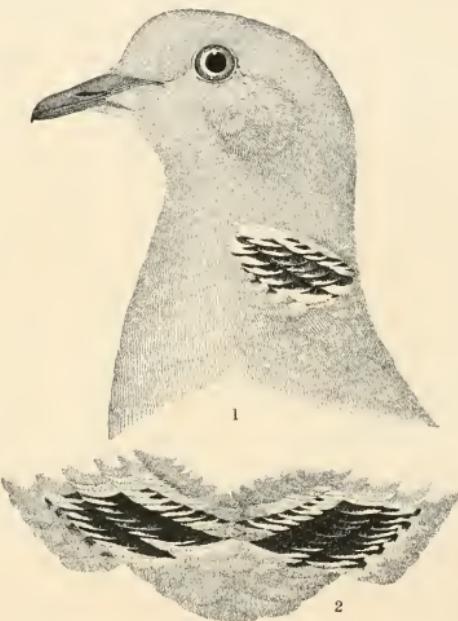
Second row shows 9 black on right, 8 on left.

Third row (central) shows 7 black on each side.

Fourth row shows 7 black on each side; the two middle (dorsal) feathers are usually covered, but are here exposed.

Fifth row (upper) shows no black; in color these are midway between the spot-feathers and the general neck-feathers; i.e., the color is merely whitened a little, no black visible, and the differentiation is not so strong as in the other rows.

There are here two *separate* marks, nearly confluent in the third and fourth rows.



two different colors. One is a little darker than the other, and this is the main difference between them. All of the light ones turn out to be females, and most, at least, of the dark ones are males. In pl. 12 one of these males is shown; it is plainly intermediate in size, color, and neck-mark. The neck-mark is shown in flat and side views in text-fig. 9. Pl. 13 displays these characteristics, leaning somewhat toward *orientalis*, in a male hybrid of the reciprocal cross. The cross between the Japanese turtle and the blond ring-dove leads to a reduction in the extent of the neck-spots in the hybrid as compared with the Japanese species. There is also less white at the tips of the feathers. The spots extend a little farther back on the neck than in *orientalis*; they very nearly meet in some cases. All these characters, therefore, undergo division in a first cross.

When the Japanese turtle-dove is crossed with the white ring-dove the chief

difference from the preceding result is that the females, and the females only, are very much lighter in color (they are nearly white) than the females of the Japanese \times blond ring cross; while the males from the *alba* \times *orientalis* cross are probably fully as dark as *risoria* \times *orientalis* offspring. One of these nearly white female hybrids is shown in pl. 9; the color is very much reduced from the mother toward the white father. But some pigment is certainly to be found, and even this bird is, therefore, to some extent an intermediate. (The situation here is similar to that found in the "white" females of the *alba* \times *humilis* cross soon to be described. A reference to the additional illustrations which are used in connection with Chapter VII will show—see pls. 10 and 11—that in both sexes, from the Japanese \times white ring cross and its reciprocal, size, general coloration, and neck-mark all present themselves as intermediates, though some characters are more clearly so than others.)

From the cross of the blond ring-dove¹³ with the European turtle-dove (shown in pl. 2) we get a hybrid that is again an intermediate of the two parents, certainly so in regard to the reduction of the spots on the wing and to the modification of the neck-mark. These points in the hybrid are clearly reproduced in color in pl. 37. (The neck-mark of the adult male hybrid is shown in text-fig. 11. These may be compared with the conditions normal for *T. turtur*, as shown more completely in pls. 2 and 36.) Then if I take this hybrid and cross it again with the blond ring, I get the wing-marks practically washed out; still enough remains of the distinctive dark color, however, to remind of the European turtle, and the neck-spots are once more reduced in the direction of the ring-dove. Two of these adult hybrids— $\frac{3}{4}$ ring-dove ($\frac{1}{8}$ *alba*— $\frac{5}{8}$ *risoria*) and $\frac{1}{4}$ European turtle-dove—are here reproduced in color, the lighter male in pl. 37, the darker female in pl. 38 (the juvenal neck-mark also in color in pl. 38; in addition, the flat neck-marks of an adult male and female are shown in pl. 39; and the juvenal neck-mark in position and flat also in pl. 39). These hybrids, represented in color, should be compared with their half-sister¹⁴ of pl. 38, whose mother was white ring instead of blond ring. Here it will be seen that the whiter dove reduced more strongly than did the brownish one the already once-divided body-color and neck-mark of the European turtle-dove. Carry the study still further by crossing the second hybrid ($\frac{3}{4}$ ring \times $\frac{1}{4}$ European turtle) with a ring-dove and we shall get nearer the ring-dove color and nearer the ring-dove size; the mark on the neck becomes quite small and of the ring-dove width, while the two side-spots are now found to touch each other on the back of the neck.¹⁵

Now, it would hardly be fair for me to stop here with my account, since in some crosses one can, apparently, obtain quite another result. When the male white ring is crossed with the female red ring (*St. humilis*) one gets sometimes a dark bird and sometimes a white one. In that cross I have obtained about as many white as dark. I have not carried this experiment far enough to know just what the results would be, but all the white young are females and most of the dark birds are males.¹⁶ One might say the white birds are like the father, while the dark birds

¹³An *alba-risoria* \times *risoria-alba* hybrid of blond color was the parent of the bird illustrated in pl. 37.—EDITOR.

¹⁴The brothers and sisters of this family show considerable variation, a fact made evident by reference to table 121. Several are not as light as the one illustrated.—EDITOR.

¹⁵No drawings of this final hybrid can be found.—EDITOR.

¹⁶See Chapter XII.—EDITOR.

are like the mother. But observation tells me not to be too confident in saying that the "white" bird is the exact reproduction of the father. In the first place, it is intermediate in size, and the white is the color that misleads us. When the bird is examined a little more closely it will be found that the tail-feathers have *some dark pigment*. The dark portion of the basal two-thirds of these feathers is the part that is very dark—almost black—in the blond ring-dove. It is evident, therefore, that we have the old pattern of the blond ring, together with some of its color, preserved here. I have not examined the other feathers of the bird microscopically or otherwise to determine how much pigment there is, but certainly there is some, as we can clearly see in the case of the tail.

This case, then, does not come to Mendel's rule, but may suggest something analogous to it. According to his rule the first hybrids are of one dominant color; the offspring of these hybrids divide, so that one quarter are like the one pure parent and another quarter like the other pure parent, and two quarters—or one-half—are like the first hybrids. In the case which we have just described the division into two colors is obtained in the first generation of hybrids, and the two colors are found to be closely associated with sex.

My main object in these remarks has been simply to present a few cases. The number of such cases that I might place in evidence could be much increased. The crosses I have made all tell the same story.

One thing, however, I would add in conclusion. According to Galton's law of ancestral inheritance, the two parents furnish, as is well known, only about one-half of the offspring, while four grandparents furnish a quarter, and the great-grandparents furnish one-eighth, and the sixteen great-great-grandparents would furnish one-sixteenth, and so on, until the offspring is represented as the unit, deriving these fractional parts from these different groups or grades of ancestors. The necessity of such a mode of reckoning lies in the fact that parents represent "mixtures." They are not "pure" to begin with. If a pure species is crossed it can be said that each parent contributes one-half, with nothing to do with other ancestors. That is, assuming that one has a pure species of birds—pure from one generation to another—one knows what he is going to get, namely, one-half of each of these species in each of the offspring. It is a very much simpler method¹⁷ than Mendel's or Galton's.

¹⁷ In the prefatory notes to this lecture Professor Whitman characterized his law, as elucidated in this chapter as that of "Pure or direct inheritance."—EDITOR.

EXPLANATION OF PLATE 37.

- A. Adult male *Streptopelia alba-risoria* \times *Turtur turtur* hybrid. (J 1). Hatched May 15, 1901; age 10 months. Six-tenths natural size. Hayashi del., March 1902.

Sire: *St. alba-risoria* \times *St. risoria-alba* (D 2). Dam: *T. turtur* (T 1-B 1).

Note the intermediate neck-mark and the reduced dark centers of the general plumage.

- B. Adult male ring-dove (J) \times common turtle-dove (L) hybrid (A 1). Age 10 months. Six-tenths natural size. Hayashi del., March 1902.

Sire: *St. risoria* (J)-*alba* (L). \times *T. turtur* (L) hybrid (D 1); a brother to hybrid drawn in color, pl. 38, fig. n.

Dam: *St. risoria* (7).

The neck-mark and dark centers of feathers reduced a second time from the *T. turtur* characters by crossing with ring-doves.

This male fertile with a *Streptopelia risoria-alba* (J) — *St. humilis* hybrid.

EXPLANATION OF PLATE 38.

- A. Adult female complex *Streptopelia* \times *T. turtur* hybrid (D 9). Hatched Aug. 10, 1904. Six-tenths natural size. Hayashi del., April 1907.

Sire: *St. alba-risoria* \times *St. risoria-alba* \times *T. turtur* (D 1). Dam: *St. alba* (O).

The neck-mark approximates to that of the ring-dove. The color of the general plumage of the sire is here much reduced.

- B. Adult female complex *Streptopelia* (J) \times *T. turtur* (J) hybrid (E 1). Hatched Aug. 18, 1901; age 7 months. Six-tenths natural size. Hayashi del., March 1902.

Sire: *St. alba-risoria* \times *St. risoria-alba* \times *T. turtur* (D 1). Dam: *St. risoria* (7).

Sister to male (A 1) of pl. 37 B. Color dark.

The neck-ring here is continuous, but narrow in the back. It includes 5 rows of feathers; 3 rows make most of the ring (shown flat in pl. 39, fig. 4). This neck-mark comes nearer the ring-dove type than does the ring of the clutchmate brother (E 2) whose neck-mark is shown in pl. 39, fig. 3.

- C. Juvenile male complex *Streptopelia* (J) \times *T. turtur* (J) hybrid (H 2). Hatched Feb. 4, 1902; age 8 weeks, 3 days. \times 1. Hayashi del., April 1902.

Sire: *St. alba-risoria* \times *St. risoria-alba* \times *T. turtur* (D 1). Dam: *St. risoria* (7).

In general appearance the ring-dove characteristics clearly predominate. Some influence of *turtur* is still seen in the shape and position of the neck-mark and in the light edge of the feathers that form it. Compare the neck-marks of a sister, fig. B, and pl. 39, fig. 4; of an adult brother, pl. 37, fig. A; and juvenile ring-dove pl. 31, figs. A, B, C; also with brother to sire, text-fig. 11.

EXPLANATION OF PLATE 39.

1. Neck-mark of juvenile male complex *Streptopelia* (J) \times *T. turtur* (J) hybrid (I). Hatched July 14, 1902; age 47 days. \times 0.6. Hayashi del., Aug. 1902.

Sire: *St. alba-risoria* \times *St. risoria-alba* \times *T. turtur* (G). Dam: *St. risoria* (6).

Compare flat view of both sides of neck in fig. 2. Note that feathers of the neck-mark are all edged with whitish-gray, after the turtle-dove pattern. In localization and in the form of the mark the influence of *turtur* is also evident.

2. Neck-mark (flat) of same bird as fig. 1. Age 47 days. \times 2. Hayashi del., Aug. 1902.

The feathers are very distinctly edged with whitish-gray. The marks do not form a continuous ring behind, but this condition is approached much more strongly than in *T. turtur*.

3. Neck-mark of adult male complex *Streptopelia* (J) \times *T. turtur* (J) hybrid (E 2); brother to female of fig. 4 below. Hatched Aug. 19, 1901; age 7 months. \times 2. Hayashi del., March 1902.

This ring is broken in middle of back of neck; two elongated side-patches of black bordered above and below with white or whitish feathers. Ring of 5 rows of feathers, but 3 rows and a little of an upper row make up all that is seen. There is a lower row entirely out of sight; on the left, one feather of this row is pulled out far enough to show the dusky gray inner web. Note that the inner web of this feather is shorter than the outer.

More black is shown in the figure at middle of the back than is seen in nature, the feathers being turned to show the black. As the neck is generally held by the bird, the black here is concealed.

The black feathers are in greater number on the right side.

4. Neck-mark of adult female complex *Streptopelia* (J) \times *T. turtur* (J) hybrid (E 1). Hatched Aug. 18, 1901; age 9 months. \times 2. Hayashi del., May 1902.

The ring is continuous but narrow in the back. Five rows of feathers; three rows from the main part. A few feathers inside the ring-area show the white tip of the *T. turtur* grand-parent, but these are perhaps less evident than in the brother shown in fig. 3 above.



A



B

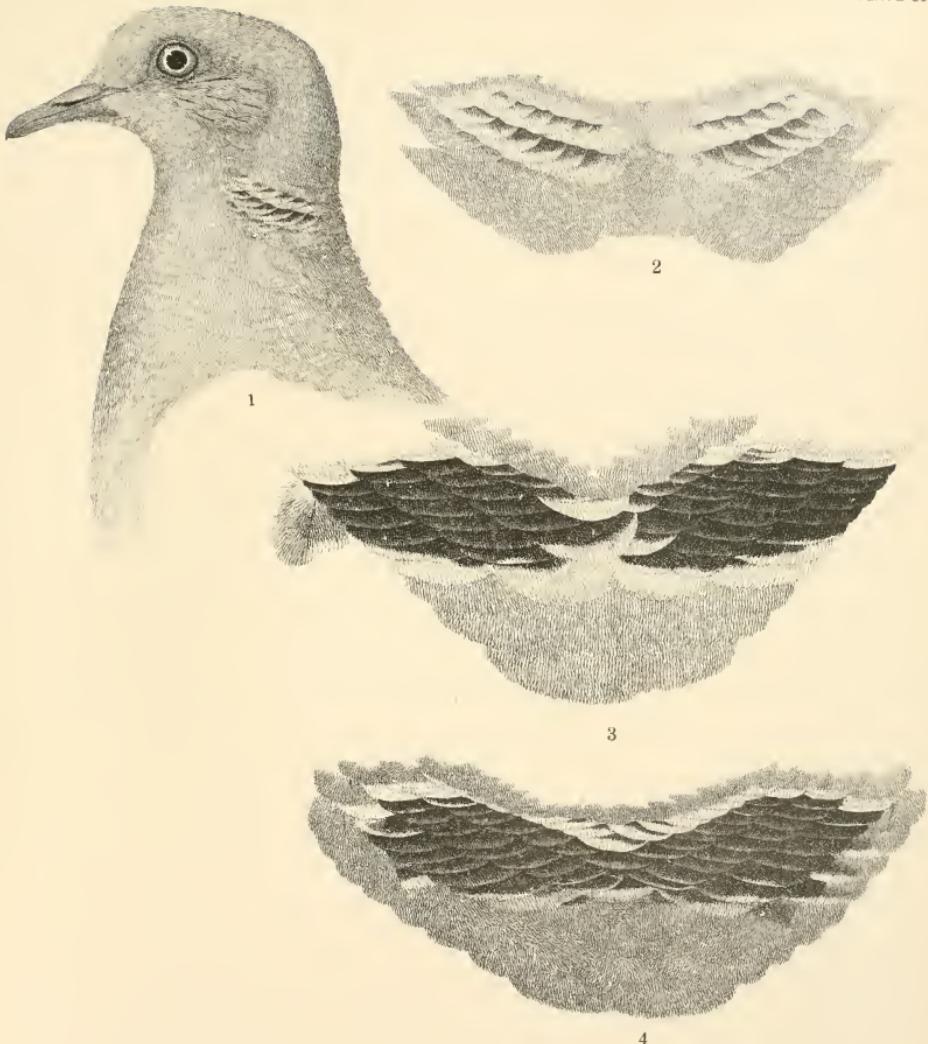
- A. Adult male, *Streptopelia alba-risoria* \times *Turtur turtur*. Hybrid (J1). Hatched May 15, 1901; age 10 months. $\times 0.6$. Hayashi del., March 1902.
- B. Adult male ring-dove ($\frac{3}{4}$) \times common turtle-dove ($\frac{1}{4}$). Hybrid (A1). Age 10 months. $\times 0.6$. Hayashi del., March 1902.



A. Adult female complex, *Streptopelia* \times *T. turtur*. Hybrid (D9). Hatched Aug. 10, 1904. $\times 0.6$. Hayashi del., Apr. 1907.

B. Adult female complex, *Streptopelia* ($\frac{3}{4}$) \times *T. turtur* ($\frac{1}{4}$). Hybrid (E1). Hatched Aug. 18, 1901; age 7 months. $\times 0.6$. Hayashi del., Mar. 1902.

C. Juvenile male complex, *Streptopelia* ($\frac{3}{4}$) \times *T. turtur* ($\frac{1}{4}$). Hybrid (H2). Hatched Feb. 4, 1902; age 8 weeks, 3 days. Natural size. Hayashi del., April 1902.



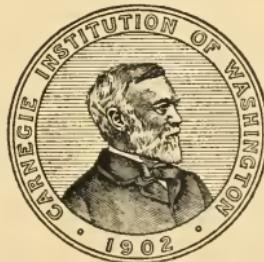
1. Neck-mark of juvenal male complex *Streptopelia* ($\frac{3}{4}$) \times *T. turtur* ($\frac{1}{4}$) hybrid (I). Hatched July 14, 1902; age 47 days. \times 0.6. Hayashi del., Aug. 1902.
2. Neck-mark (flat) of same bird as figure 1. Age 47 days. \times 2. Hayashi del., Aug. 1902.
3. Neck-mark of adult male complex *Streptopelia* ($\frac{3}{4}$) \times *T. turtur* ($\frac{1}{4}$). Hybrid (E2); brother to female of figure 4 below. Hatched Aug. 19, 1901; age 7 months. \times 2. Hayashi del., March 1902.
4. Neck-mark of adult female complex *Streptopelia* ($\frac{3}{4}$) \times *T. turtur* ($\frac{1}{4}$). Hybrid (E1). Hatched Aug. 18, 1901; age 9 months. \times 2. Hayashi del., May 1902.

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